This is a digital copy of a book that was preserved for generations on library shelves before it was carefully scanned by Google as part of a project to make the world's books discoverable online.

It has survived long enough for the copyright to expire and the book to enter the public domain. A public domain book is one that was never subject to copyright or whose legal copyright term has expired. Whether a book is in the public domain may vary country to country. Public domain books are our gateways to the past, representing a wealth of history, culture and knowledge that's often difficult to discover.

Marks, notations and other marginalia present in the original volume will appear in this file - a reminder of this book's long journey from the publisher to a library and finally to you.

Usage guidelines

Google is proud to partner with libraries to digitize public domain materials and make them widely accessible. Public domain books belong to the public and we are merely their custodians. Nevertheless, this work is expensive, so in order to keep providing this resource, we have taken steps to prevent abuse by commercial parties, including placing technical restrictions on automated querying.

We also ask that you:

+ *Make non-commercial use of the files* We designed Google Book Search for use by individuals, and we request that you use these files for personal, non-commercial purposes.

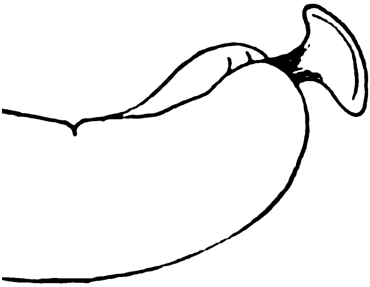
+ *Refrain from automated querying* Do not send automated queries of any sort to Google's system: If you are conducting research on machine translation, optical character recognition or other areas where access to a large amount of text is helpful, please contact us. We encourage the use of public domain materials for these purposes and may be able to help.

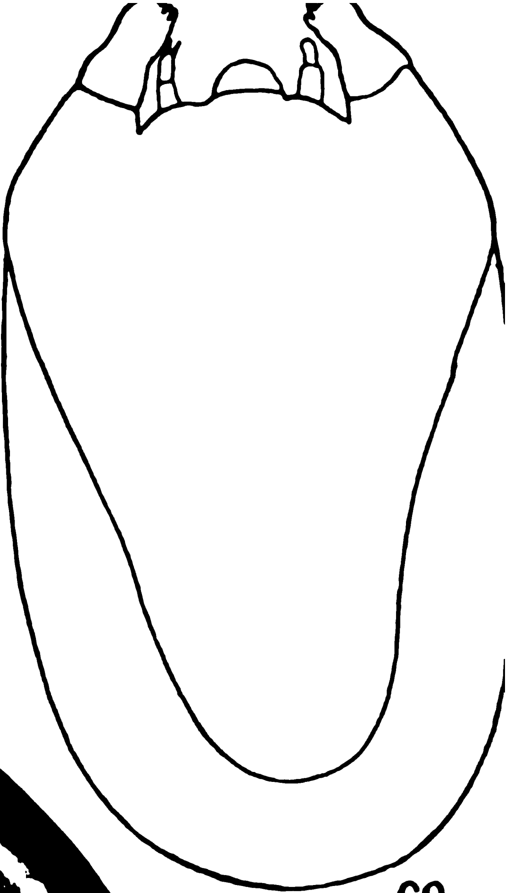
+ *Maintain attribution* The Google "watermark" you see on each file is essential for informing people about this project and helping them find additional materials through Google Book Search. Please do not remove it.

+ *Keep it legal* Whatever your use, remember that you are responsible for ensuring that what you are doing is legal. Do not assume that just because we believe a book is in the public domain for users in the United States, that the work is also in the public domain for users in other countries. Whether a book is still in copyright varies from country to country, and we can't offer guidance on whether any specific use of any specific book is allowed. Please do not assume that a book's appearance in Google Book Search means it can be used in any manner anywhere in the world. Copyright infringement liability can be quite severe.

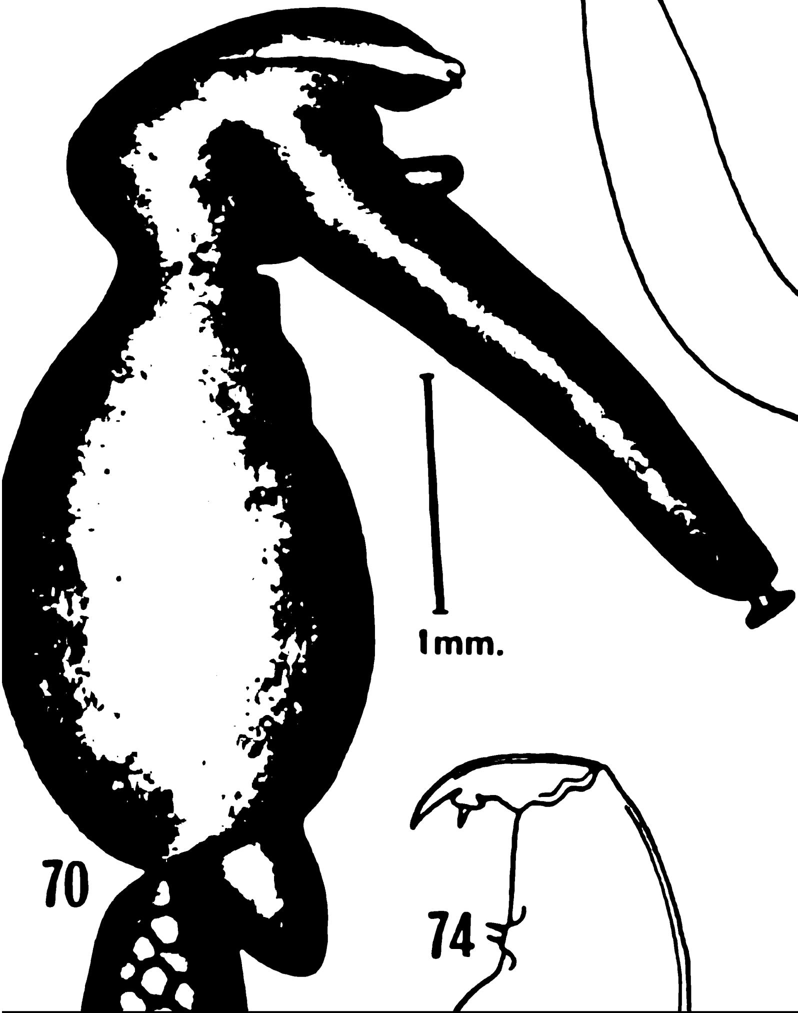
About Google Book Search

Google's mission is to organize the world's information and to make it universally accessible and useful. Google Book Search helps readers discover the world's books while helping authors and publishers reach new audiences. You can search through the full text of this book on the web at `http://books.google.com/`



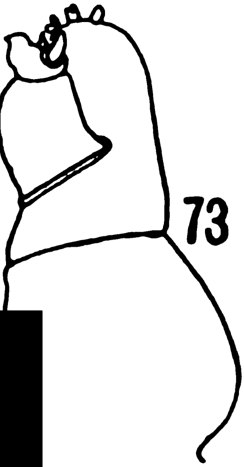


69



70

74



73

North American parasitic copepods belonging to the Lernaeopodidae

Charles Branch Wilson, United States National Museum

Bound 1938

HARVARD UNIVERSITY

VE RI TAS

LIBRARY

OF THE

MUSEUM OF COMPARATIVE ZOÖLOGY

42,131

NORTH AMERICAN PARASITIC COPEPODS BELONGING TO THE LERNAEOPODIDAE, WITH A REVISION OF THE ENTIRE FAMILY

BY

CHARLES BRANCH WILSON
Department of Biology, State Normal School, Westfield, Massachusetts

No. 2063.—From the Proceedings of the United States National Museum,
Vol. 47, pages 565–729, with Plates 25–56

Published March 6, 1915

FOR THE INCREASE AND DIFFUSION OF KNOWLEDGE AMONG MEN
PER ORBEM
SMITHSONIAN INSTITUTION WASHINGTON 1846

Washington
Government Printing Office
1915

NORTH AMERICAN PARASITIC COPEPODS BELONGING TO THE LERNAEOPODIDAE, WITH A REVISION OF THE ENTIRE FAMILY.

By Charles Branch Wilson.
Department of Biology, State Normal School, Westfield, Massachusetts.

INTRODUCTION.

The present is the eleventh[1] paper in the series based on the collection of parasitic copepods in the United States National Museum and deals with the family Lernaeopodidae.

For several reasons the necessity of supplemental study has been greater than in connection with any of the families previously treated. The Lernaeopodidae are soft-bodied, without any chitin framework, external or internal, to hold them in shape. Consequently they shrink and often become so distorted during preservation that the museum specimen gives very little idea of the original. Most of the species are transparent when alive, and much of their internal anatomy can then be plainly seen. But in a preservative they become opaque and require dissecting or sectioning before anything can be learned with regard to their internal structure.

Finally a knowledge of both sexes of the various genera, and of the developmental stages through which the larvae pass has been found necessary for the establishment of a rational basis of classification. And the greater bulk of such information must be obtained outside of a museum collection.

The development of the family was worked out at Lake Maxinkuckee, Indiana, during the summers of 1906, 1908, and 1909, and has already been published as the ninth paper of the present series.

Isolated developmental stages and the males of many species were obtained at Beaufort, North Carolina, while working for the United

---

[1] The ten preceding papers, all of which were published in the Proceedings of the United States National Museum, are: 1. The Argulidae, vol. 25, pp. 635–742, pls. 8–27. 2. Descriptions of Argulidae, vol. 27, pp. 627–655, 38 text-figures. 3. The Caliginae, vol. 28, pp. 479–672, pls. 5–29. 4. The Trebinae and Euryphorinae, vol. 31, pp. 669–720, pls. 15–20. 5. Additional notes on the Argulidae, vol. 32, pp. 411–424, pls. 29–32. 6. The Pandarinae and Cecropinae, vol. 33, pp. 323–490, pls. 17–43. 7. New Species of Caliginae, vol. 33, pp. 593–627, pls. 49–56. 8. Parasitic Copepods from the Pacific Coast, vol. 35, pp. 431–481, pls. 66–83. 9. Development of *Achtheres ambloplitis* Kellicott, vol. 39, pp. 189–226, pls. 29–36. 10. The Ergasilidae, vol. 39, pp. 263–400, pls. 41–60.

Proceedings U. S. National Museum, Vol. 47—No. 2068.

States Bureau of Fisheries. For these excellent advantages the author is indebted to the courtesy of the Hon. George M. Bowers, former United States Commissioner of Fisheries.

The internal anatomy has been derived partly from the study of living specimens at each of the above localities, and partly from serial sections made in the laboratory of Johns Hopkins University, as noted in the ninth paper above mentioned.

A number of specimens, including several of the new species, were collected by Dr. Edwin Linton during his investigations on the cestode and trematode parasites of fishes, and were generously turned over by him to the present author. These specimens are always excellently preserved and have proved of great value in the present study.

Several years ago Dr. R. R. Gurley, at that time in the employ of the United States Bureau of Fisheries, collected in manuscript form all the available data regarding copepods parasitic upon our North American freshwater fishes. These notes have been placed at the author's disposal, and as they included complete translations of everything written on North American species by foreign authors they have proved extremely valuable. Acknowledgment is made in the text whenever these notes have been incorporated.

Dr. Nathan Fasten, of the Department of Zoology at the University of Wisconsin, has recently published three excellent papers on the habits and development of a species of this family which infests the common brook trout. At the author's request Dr. Fasten very kindly loaned mounted specimens of the copepodid larvae and male of this species, *Salmincola edwardsii*, which have been of much use for study and comparison.

As here constituted the family includes 23 genera and 136 species, of which 12 genera and 21 species are new to science.

In addition there are several other genera and species which at one time or another have been included in this family, but which must be regarded as synonyms or as not sufficiently well established to be definitely located.

ECOLOGY.

Wherever the Lernaeopodidae may be placed in any scheme of classification, all authors will agree that they are fixed parasites and extremely degenerate. Consequently we should look for marked sexual dimorphism, a partial or total loss of the powers of locomotion, and a corresponding complexity in the means of prehension. And we find these abundantly exemplified.

Sexual dimorphism.—The differences between the sexes manifest themselves not only in an enormous disparity in size, coupled with a corresponding dissimilarity in the structure of the body and its appendages, but also in the methods and extent of prehension and locomotion. Such dimorphism as has to do with structure will be treated under morphology (see p. 571), while that which concerns locomotion and prehension follows under those headings respectively.

Locomotion.—The larvae alone in this family possess the ability to swim about freely and that only for a remarkably short period, during which they must seek out a host and attach themselves to it. During this free stage the larva swims about actively with a jerky spiral motion by means of its two pairs of swimming legs. Fasten in his experiments with the brook trout parasite, *Salmincola edwardsii*, found that the average distance covered by a single contraction of the swimming legs was about an inch. When the motion ceased the larva at first took an upright position, then turned upside down and sank to the bottom where it lay as it struck, with either the dorsal or ventral side uppermost. It was also able by means of its first antennae to cling to the side of the aquarium, or to suspend itself from the surface film of the water. By means of its peculiar spiral locomotion it is enabled to cover the maximum of territory with the minimum of muscular energy.

Female.—After the female larva has once become attached it can not loosen this connection and form another, but must remain in the same place all the rest of its life. If the arms (second maxillae) are short, as in many species of *Clavella*, scarcely any freedom of motion can be enjoyed. The parasite is not only fixed in position, but it can not turn or flex its body, and becomes fully as helpless as some of the Lernaeidae or Chondracanthidae, whose head and neck are buried in the flesh of their host. On the other hand, if the attachment organs are long and slender as in many species of *Brachiella*, *Lernaeopodina*, etc., while the tips of these arms remain at a fixed point the body of the parasite can describe quite an arc. The arms are supplied with powerful muscles which swing the body to one side or restore it again when once displaced. In this way the animal often escapes being brushed or scraped off from the fish, especially those species which attach theselves to the fins, where, of course, there is the greatest danger. After the female is once fastened to her host she loses during subsequent moults the two pairs of swimming legs which were all the locomotor organs she ever possessed. She finds excellent aeration for her eggs and a good position from whence to discharge the copepodid larvae when once they have matured. And there is also an abundance of food, so that she is well provided for during life.

Male.—The free-swimming period of the male larva is no longer than that of the female, and the two often fasten themselves side by side upon the same fish. But while this attachment is permanent in the case of the female, it is only temporary for the male.

When the two have become sexually mature the male, on swinging around upon its attachment filament and coming in contact with the body of a female, lets go of the filament and fastens himself to the female by his second maxillae and maxillipeds, and remains upon her body for the rest of his life. Not being permanently fixed, he is able to crawl about over the female's body, and is found sometimes in one position, sometimes in another. But such motion is slow amd laborious and probably is only practiced when necessary. Unlike the female the male does not always lose his swimming legs, but may retain them; they become very small and dwarfed, however, and lose all their swimming setae, so that they are no longer of any service as locomotor organs. Furthermore the male does not increase in size with successive molts like the female, but remains dwarfed, little if any larger than in its copepodid stage. The mating of the sexes in this family takes place upon reaching maturity, just after the molt at the close of the second copepodid stage. But the male may remain clinging to the body of the female long after this mating, sometimes possibly throughout the life of the latter.

Prehension.—The organs of prehension are the second maxillae and maxillipeds. As explained elsewhere,[1] the copepodid larvae, both male and female, seize their host with the maxillipeds, rub the frontal margin of the head against the skin of the gill arch or fin until the outer end of the attachment filament is firmly glued in place by means of the adhesive fluid it contains. As the coiled filament is drawn out of the head, or subsequently, the larva grasps its inner end between the claws at the tip of its second maxillae.

Fasten,[2] observing *Salmincola edwardsii* under the microscope, describes its attachment as follows: . . . "As soon as the copepod comes in contact with the filament of the gill its mouth parts (maxillipeds) are inserted into the flesh, and by means of the powerful claw-like second maxillae it begins to rasp the filament until it forms a cavity within it. As soon as this occurs, the anterior portion of the copepod's head, the frontal margin, is brought in contact with the cavity and the inclosed attachment filament is injected into the hole. The spherical mushroom body adheres to the flesh and the regenerating tissue of the gill soon incloses it tightly, thereby fastening the organism firmly. The mouth parts are then withdrawn from the flesh of the gill filament. In this condition the parasite remains attached for a short time. Then the second maxillae detach the posterior region of the attachment filament from the head margin and they themselves become permanently attached to this end of the filament."

The exact time or even the method of attachment are specific or generic in significance. That which concerns us in dealing with the family is the fact that the larva is attached at the first by a frontal filament. The proximal end of this filament is afterwards transferred to the second maxillae, which thus become the organs of prehension in the adult. The hold thus secured is retained by the female throughout life, the second maxillae gradually elongating and fusing with the filament. In most of the species these organs become so long that they entirely usurp the function of prehension, and leave the maxillipeds out of commission, so far as holding the parasite on its host is concerned.

---

[1] Proc. U. S. Nat. Mus., vol. 39, p. 211.

[2] Journ. Animal Behavior, vol. 3, No. 1, p. 56.

In the male such fusion does not take place, but as soon as he has found a female the second maxillae release the frontal filament and are afterwards used in a normal manner as prehensile organs along with the maxillipeds. Accordingly in the male the second maxillae retain their original musculature, which is similar to that of the maxillipeds. And the male uses these two pairs of appendages in exactly the same manner, moving about the little that it is able by employing them alternately, grasping with the maxillipeds while it reaches forward with the maxillae and obtains a new hold, then releasing and reaching forward with the maxillipeds. In this way the organs serve the double purpose of prehension and locomotion, in fact all the locomotion of which the adult males are capable.

In the female, on the contrary, the musculature of the second maxillae becomes highly modified. There is no further use for the claws, and so the muscles that would otherwise move them become atrophied. The rest of the muscles are gathered into long bands or bundles, which run the entire length of the maxilla and are strong enough to move the whole body, Such modified organs of prehension are, so far as known, peculiar to the females of the present family, and nothing like them is found in any of the other copepods. After being once attached the females are incapable of any further locomotion, even the sort practiced by the males so that neither pair of appendages can function for this purpose. If there were not some further use for the maxillipeds we should expect to find them dwarfed or degenerated, but they retain to the full their shape and powerful musculature. This is because the female uses them in procuring her food. Ordinarily her body hangs free from the host, supported solely by the second maxillae. In order to obtain requisite nourishment the head and mouth of the parasite must be drawn up to, and held in contact with, the skin of the host. This is done by means of the maxillipeds, and is fully as important a function as the one served by the second maxillae.

Hosts.—This family of parasites is widely distributed amongst fishes in both salt and fresh water. Some of our best food and game fish are infested with them, and when they once obtain entrance to a stock pond, fish hatchery, or aquarium they usually multiply so rapidly as to become a serious nuisance, and may even kill the fish.

Their free swimming period is, of course, the only time that their enemies can get access to them, and this period is so brief that not many of the larvae are killed.

But the brevity of this period also operates as a regulator to prevent the parasites from becoming too numerous. For unless they find a host during this period they quickly perish. The shorter the period, therefore, the fewer will be those whose search is successful. In the crowded confines of a stock pond, on the contrary, practically every larva is sure of finding a host. And all too often the gills of the fish become so crowded with parasites that they can not perform their normal functions, and the fish are suffocated. Among fresh-water hosts the various species of trout and salmon, the white fish of the Great Lakes region, and the bass and perch are the ones most infected, the parasites being confined to the two genera *Salmincola* and *Achtheres*.

Among salt-water fish many members ot the large family of Gadidae, particularly the cod and haddock, the mullets (Mugilidae) the rays (Dasyatidae), the skates (Rajidae), and the sharks are the most common hosts.

Food.—These parasites feed upon the blood of their host, as is shown by the fact that they fasten to the gills or fins. They are also furnished with mandibles which were evidently designed for piercing the skin of their host, and whose margin is cut into saw teeth, which not only penetrate the flesh but also lacerate the wound and thus stimulate the flow of blood. Adult females are frequently obtained with their alimentary canal filled with blood, but the color of the latter is quickly removed by the digestive fluids. It is a question whether the male ever eats anything at all, and if he does, what constitutes his food. The following facts and considerations have an important bearing on this question:

1. The adult male possesses a pair of mandibles as large, as powerful, and as suited for laceration as those of the female. He has also a well-developed esophagus and stomach, but in all those examined there is no trace of an intestine or anus.

2. There are no digestive glands connected with the alimentary canal, but the stomach is lined with large gland cells, which are filled with a liquid that undoubtedly aids in digestion. The abundance of these cells more than compensates for the lack of glands, and would be amply sufficient to digest such food as blood.

3. The excretory glands are exceptionally large and are provided with good-sized ducts. It would seem as if they could take care of all the residue that would be left undigested.

4. The male does not live on the body of the host, but clings tightly to some convenient place on the body of the female, and no specimens have ever been found on the fish's gills, although repeated search has been made for them. Males have been found clinging to the second

maxillae of the female, and it is possible that they can crawl along these appendages to the fish's gills and there obtain food. But that does not seem very likely, because there are many species in which the second maxillae are as long as the entire body, and a few species in which they are two or three times the body length. Such a distance would make a rather long journey for so slow moving a creature as the male, and if it was a case of traversing the distance or going hungry, it would most likely result in the latter. Possibly the male may be brought close enough to the gill when the female draws her body down to obtain food. At all events the male must derive whatever food he eats from the fish host and not from the body of the female.

5. The spermatophores attached by the male to the sexual openings of the female are large and contain a goodly number of spermatozoa. Probably a single pair of them would supply the female with sufficient spermatozoa to fertilize all the eggs she can lay during her lifetime. Furthermore, the careful study of the sexual organs of the male given on pages 590, 691, indicates that only a single pair of these spermatophores are formed. Hence it is unlikely that the male lives very long after fastening the first pair in place.

6. Both sexes necessarily go without food during the free swimming period, since their mouth parts then are only suited for obtaining food parasitically. During the second copepodid stage they both suck the blood of the fish upon which they have fastened. The female uses this food to increase greatly in size, as well as to develop her various organs. The male does not increase at all in size, but devotes all his food to the maturing of the spermatophores. After these are fully developed and put in place on the body of the female no more food is required unless a second pair is to be formed, and even then the amount of food demanded would be relatively much smaller. On the contrary, the female must have an abundance of food to ripen her eggs, to carry them in the external sacks until they hatch, and to form, ripen, carry, and hatch successive new batches of eggs. In view of these considerations it is reasonable to suppose that the duration of life for the male is much shorter than that of the female. He requires little, if any, food after he has transferred from the host to the body of the female. And the absence of an intestine and anus would insure the complete digestion and absorption of all the food taken previously. It seems probable, therefore, that the male does eat the fish's blood while it remains attached to the gills, but that it gets no food after it has transferred to the body of the female.

MORPHOLOGY.

General body form of female.—Owing to the degeneration consequent upon fixed parasitism there has been a fusion and elimination of the various body regions. We can no longer distinguish a cephalon, a free thorax, a genital segment, and an abdomen as in the less degenerate families. These are separated in the copepodid stages of development, and may then be discerned with comparative distinctness. But they are entirely lost in subsequent moults, and the body of the adult female usually shows only two regions, and even these are sometimes (*Basanistes*) so fused that it is difficult to distinguish them.

The first region corresponds to the cephalothorax in other copepods, and includes the head with its antennae and mouth parts, the neck, which is sometimes half the entire length or more, and the organs of attachment, the second maxillae. The remainder of the animal is fused together to form the other region, which we may call the trunk and which thus includes the posterior portion of the thorax, the genital segment and the abdomen.

In the copepodid stages the segmentation of the trunk is distinct, but it gradually disappears with maturity, until it becomes wholly lost in the adult (*Clavella*, *Basanistes*), appears only in the anterior portion of the trunk (*Lernaeopoda*), or is indistinct with a fusion of some of the parts (*Achtheres*). But even in those genera which exhibit the most complete fusion of the body parts the musculature is still broken at regular intervals, each of which indicates a point of segmentation.

In some species of *Salmincola*, *Clavella*, etc., there is also a small knob at the posterior end of the trunk, which is well separated from the rest of the body and which has always been called an abdomen. But it is so rudimentary and insignificant when it does appear, and it is so often lacking that it would not be worthy of consideration as a separate body region were it not for the fact that we do find well-differentiated abdomens in the genera *Achtheres* and *Naobranchia*. Accordingly we must determine whether the knob is a true abdomen, corresponding morphologically to those in the two genera just mentioned or whether it is simply a process. On examining serial sections of *Clavella uncinata* we find that the anus opens on the posterior end of the trunk, ventral to the base of the process, while the intestine does not enter the process at all. There is an opening at the distal end of the process, and a tube leading through its center. But this is a sperm tube and leads into a sperm receptacle, which is dorsal to the intestine. The outgrowth, therefore, can not in any way be regarded as an abdomen, but is purely sexual in structure and function. And we would propose for it the name of genital process. To this knob the male clings while he fastens the spermatophores on its tip; from these spermatophores the sperms pass into the tube and thence up into the sperm receptacle. As further proof that this is not an abdomen there are never any anal laminae on it, while they frequently do occur on the posterior end of the trunk (fig. 1).

The size of the process is somewhat proportional to the size of the male; in the genus *Clavella* both the male and the process are very small, while in *Brachiella* the males are large and the process is increased proportionally.

In the cephalothorax the general relations and the varying structure of the head, neck, arms, and trunk furnish very useful generic characters. We may distinguish first genera in which the head and neck are long and slender and flexed dorsally at an angle with the trunk. The second maxillae may be in the same line with this elongated cephalothorax and of about the same length, the two standing across the anterior end of the trunk like the top of the letter T (*Brachiella, Thomsonella, Brianella*).

Or the second maxillae may be much shorter than the cephalothorax and inclined at a different angle (*Clavellodes, Clavellopsis, Naobranchia*). Sometimes the cephalothorax is bent back so far that it rests against the dorsal surface of the trunk and the creature looks as if it were folded and hung from the bend of the fold (*Clavella*). And in one genus (new) there has been a fusion after such a bending, and as a result the cephalothorax is attached to the center of the dorsal surface of the trunk and stands out at right angles to the axis of the latter, while the second maxillae are attached to the anterior end of the trunk some distance from the base of the cephalothorax (*Clavellisa*).

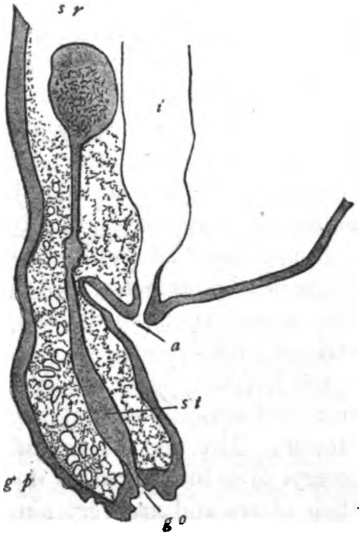


FIG. 1.—SECTION OF CLAVELLA UNCINATA SHOWING *a*, ANUS; *go*, GENITAL OPENING; *gp*, GENITAL PROCESS; *sr*, SPERM RECEPTACLE; *st*, SPERM TUBE; *i*, INTESTINE.

In a second group we find genera in which the head and neck are shorter and stouter, and they either stand in line with the axis of the trunk or are curved over (not flexed at an angle) ventrally. The second maxillae may also be short and stout and stand out at right angles to the trunk axis, and they as well as the posterior margin of the trunk may be hung with fimbriate processes (*Thysanote, Thysanotella*). Or they may be perfectly smooth while the posterior margin of the trunk is furnished with cylindrical processes (*Brachiella, Epibrachiella*).

Again the second maxillae may be long and slender and inclined at an acute angle to the trunk axis, either forward or backward.

They may be entirely separate, each ending in a clasping process (*Charopinus*), or they may be joined by an ordinary bulla. In this latter condition the posterior margin of the trunk may be wholly without processes (*Tracheliastes*) or may have a single ventral pair (*Parabrachiella*) or a single dorsal pair (*Charopinus*).

In the third group we find genera in which there is no neck at all; the head is short and wide and may be in line with the trunk axis or inclined to it. When the two are in the same line we may find a single pair of processes on the posterior margin of the trunk which are either ventral (*Lernaeopoda*) or dorsal (*Lernaeopodina*) to the egg strings. If there are no posterior processes (*Vanbenedenia*) the second maxillae extend straight forward, are rigid, and their base has been moved until they are virtually dorsal instead of ventral or lateral, and cover the back of the head. When the head and trunk are inclined to each other we find no posterior processes, but there may be an unpaired median genital process (*Salmincola*) like that in *Clavella*. The second maxillae are also usually turned backward along the ventral surface of the trunk and their bases are connected around the posterior end of the head by a stout ridge.

Calling the second maxillae by the common name of arms, these enlarged bases correspond to a pair of misshapen shoulders.

Sometimes the trunk is covered with longitudinal rows of knobs or tubercles (*Basanistes*). Again there are neither knobs or shoulders, but there is a well-defined abdomen behind the bases of the egg strings (*Achtheres*).

General body form of male.—The male never becomes fixed in position and hence does not usually show as much degeneration as the female. The second maxillae are never permanently attached by means of a bulla and so do not develop into long arms, but retain their claws and are very similar to the maxillipeds both in form and function. The trunk is distinctly segmented more often than in the female and is usually furnished at the posterior end with a pair of well-defined anal laminae.

In some genera the cephalon and in others the whole body is covered with a carapace, but in the majority of genera this is lacking. The male remains a pigmy and there is a greater disparity in size between the two sexes than can be found anywhere else among the parasitic copepods.

There is also a folding of the body in these males, but in a manner different from that just described for the females.

In the female the cephalothorax was flexed either forward or backward and sometimes rested against the dorsal surface of the trunk, but there was no fusion of the two parts except in the single genus *Clavellisa*. Here in the males, on the contrary, the cephalothorax is always folded forward against the ventral surface of the trunk, and the two are frequently so thoroughly fused as to be indistinguishable.

The different genera show varying amounts of flexion and fusion and we may separate the types as follows:

1. The cephalothorax and trunk may be approximately in the same straight line, when of course there is neither flexion nor fusion.

These are large males, a millimeter or more in length; the mouth tube, the antennae, and the first maxillae point forward in the same direction as the body axis, or but little inclined to it and the anal laminae similarly point backward; the second maxillae and maxillipeds extend outward at right angles to this axis.

The trunk may be well segmented (*Achtheres* and *Thysanotella*), partially segmented (*Epibrachiella*), or wholly devoid of segmentation (*Thysanote*, *Brachiella*, and *Vanbenedenia*). There is a carapace covering the entire body in *Thysanote*, a well-defined cephalic carapace in *Brachiella*, a poorly defined one in *Epibrachiella*, and none at all in the other three genera.

2. The cephalothorax may be turned forward at right angles to the trunk axis, so that the mouth tube, the antennae, and the first maxillae point outward parallel with the second maxillae and maxillipeds; the anal laminae usually point outward also, though they may point backward (*Charopinus*), or may even be turned dorsally (*Lernaeopoda*). The trunk may be well segmented (*Charopinus*, immature *Lernaeopoda*), or may show no signs of segmentation (*Probrachiella*, *Parabrachiella*, adult *Lernaeopoda*). *Lernaeopoda* has a distinct cephalic carapace, *Charopinus* has a larger but less distinct one, while *Parabrachiella* and *Probrachiella* have no trace of any.

3. There may be two flexures, the mouth tube and antennae being parallel with the greatly reduced trunk, as well as with the maxillae and maxillipeds, while the posterior portion of the cephalothorax stands at right angles to all of them. This is found in the single genus *Lernaeopodina*, whose males are considerably smaller than those of the other genera already mentioned.

We have here therefore complete flexion but no fusion; there is no carapace visible and the trunk shows no traces of segmentation.

4. There may be similar flexion combined with fusion so that we can no longer distinguish the body regions. The sexual opening is at the end of a rounded process just behind the second maxillae, and extending outward parallel with them, and the anal laminae have entirely disappeared. What was originally the long diameter of the body may still be longer than the transverse diameter (*Naobranchia*, *Clavellopsis*) or the latter may have increased sufficiently to exceed the former (*Clavellisa*, *Clavellodes*). The result in *Clavellodes* is peculiar; there is apparently an oblong body, squarely truncated at one end, with the mouth tube and all the appendages arranged along this truncation, parallel with the long axis. But this is really the same flexion that was seen in *Lernaeopodina* combined with complete

fusion, so that the long axis is actually transverse and not longitudinal.

In *Naobranchia* the sexual process is as long as the maxillipeds and suggests very strongly the trunk of *Lernaeopodina;* there is also a carapace which covers the entire body.

5. Finally in the genus *Clavella* there has been an even greater flexion and fusion of the body, for now the sexual process is closer to the second maxillae and sometimes is carried forward to a point between them, so as to be concealed in side view.

The transverse diameter is still longer than the longitudinal one, and there are no signs of any carapace.

The eye.—None of the adults in any genus possess eyes; the eye in this whole family is extremely rudimentary, appears only for a short time during the development stages, and then entirely disappears.[1]

The appendages.—In the adults of both sexes there are six pairs of appendages, namely, two pairs of antennae, one pair of mandibles, two pairs of maxillae, and one pair of maxillipeds. The reason for regarding the penultimate pair as second maxillae is that they appear in early development in front of the suture which separates the head from the thorax, while the posterior pair appear behind that suture.[2]

In the adult males of the genus *Achtheres* there may be also one or two pairs of very rudimentary swimming legs. But these are only vestiges of the developmental stages and probably disappear at the first molt after the male has attached himself to the female. Kurz claims (1877, p. 400) to have found in the female of *Clavellisa emarginata* on the posterior end of the trunk the rudiments of the last pair of swimming legs. Before admitting this claim we must consider first the fact that only two pairs of legs appear during development and these are attached to the two anterior segments of the free thorax. If either of these pairs remained in the adult stage they must have migrated the whole length of the trunk in order to appear on its posterior margin. On the other hand, it would be rather strange for the rudiments of the fifth or sixth pair of legs to appear in the adult when only two pairs appeared in the developmental stages.

Again, if Kurz's three figures (pl. 25, figs. 8, 9, and 10) be carefully compared with respect to the orientation of the trunk, it will be seen that figure 8 (designated "Bauchansicht") actually represents the ventral surface of the trunk and the dorsal surface of the cephalothorax, except the head, which is turned in profile. In figure 10 (designated "vom Bauch gesehen") the cephalothorax has been turned forward out of its natural position, and we are actually looking at the dorsal surface of both cephalothorax and trunk. But this is the surface on which the so-called swimming legs appear, and their presence in such a position is difficult to understand.

---

[1] Proc. U. S. Nat. Mus., vol. 39, p. 204. Compare also fig. 13, p. 593.

[2] Compare also Hansen, 1893, p. 421; Giesbrecht, 1893, p. 84; Claus, 1895, p. 56; Wilson, 1910, p. 200; 1911, pp. 281 and 323.

The antennules or first antennae.—These are attached to the frontal margin of the head, between the bases of the second antennae and the proboscis, often somewhat more on the ventral than on the dorsal surface, but usually the most dorsal of all the appendages.

In *Tracheliastes* and *Basanistes* they arise on the dorsal surface of the head and are not turned downward and forward as in the other genera. They are extremely simple and are made up of three or four joints, more or less distinctly separated. The basal joint is the thickest and is fused with the head, the other joints are cylindrical and taper distally, and the terminal joint is armed with a few short nonplumose setae or spines.

The antennae, or second pair.—These are characteristically modified in the present family. They arise from what may be termed the anterior corners of the head on either side; they are flattened laterally and turned forward and inward along the anterior margin of the head, until in some species their tips meet or even overlap at the midline. They are made up of a thick basipod and two short rami, one dorsal and one ventral; the endopod or dorsal ramus is usually much larger than the exopod, is thick and fleshy, unsegmented, and bluntly rounded at the tip, where it is armed with a few short spines or teeth (*Charopinus, Achtheres, Brachiella*), sometimes with olfactory cylinders (*Clavella,* sp.) or even with claws (*Lernaeopoda,* sp.). The exopod is slender and cylindrical, usually two-jointed, and is tipped with tactile hairs, olfactory cylinders, or a chitin claw.

The claw is more common in the male, where these antennae serve as attachment organs, where they have a stout musculature, and where the claw sometimes shuts down against the terminal joint and is chelate in function. In rare instances in the female the two rami are arranged like the jaws of a chela and must function as a grasping organ (*Lernaeopodina longimana* and *Charopinus ramosus*).

The mouth tube or proboscis.—This is attached between the bases of the second antennae, is conical in shape, and is directed downward and forward against the skin of the host. It is composed of an upper and an under lip; each side of the latter is split into two lamellae, between which is fastened the corresponding side of the former, so that the two lips are loosely joined along their lateral edges to form a closed tube. But they are not held together very firmly, and it is an easy matter to separate them with a needle (fig. 2). At the base of these lateral seams both lips are cut away a little to form a three-cornered opening through which the mandible projects into the interior of the tube.

The under lip is somewhat larger than the upper and more spoon-shaped, so that its anterior end, around the mouth opening, is curved like a horseshoe. The upper lip is flatter, broadened at the base, and narrowed toward the tip, which is bluntly rounded and armed with a tuft of fine hairs, or with a short spine. Each lip is supported around its margin by a chitin framework, which is articulated with the chitin framework of the head, so as to allow the proboscis to move freely backward and forward. The anterior margin of the under lip around the mouth opening is also divided into two lamellae, of which the inner one serves to contract the mouth opening while the outer one is cut into a fringe along its free margin. The length and thickness of this fringe varies considerably in different genera and species. Usually it is more than half the width of the lamella, in which case the fringe looks as if it were made of stiff hairs standing in rows around the mouth opening. Again, the fringe may be so short that it can only be detected with difficulty, and hence appears to be lacking (*Naobranchia*).

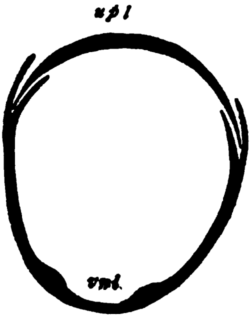


FIG. 2.—CROSS SECTION OF PROBOSCIS (DIAGRAMMATIC); *upl*, UPPER LIP; *vnl*, LOWER LIP.

When the proboscis is applied to the host for the purpose of drawing blood, this bordering fringe, together with the rest of the membrane, is spread out around the tip of the proboscis like a sucking disk and probably assists in obtaining the blood.

There are no chitin rods nor any supporting framework in this sucking border, as was clearly shown by Kurz.

The mandibles are rigid chitinous blades, operating inside the proboscis, although they originate on the ventral surface of the head, outside of it, and only become inclosed when the edges of the upper and lower lips are fastened together. The base of the mandible always remains outside of the proboscis, inserted in a fold of the skin, and only the blade or terminal portion enters the mouth tube through the triangular opening at the base of the two lips. The blade of the mandible reaches to the tip of the proboscis, or may even project a little beyond the latter. It is strongly flattened dorso-ventrally and brought to a sharp edge along the two lateral margins. It is widest at the center and tapers toward both ends; it is also frequently bent at or near the center, so that the terminal portion curves in toward its fellow on the opposite side. At the tip the inner margin is cut diagonally and set with wicked teeth.

Kurz distinguished three kinds of these mandible teeth; the first he called principal teeth (Hauptzähne). They are much larger and stouter than the others, they usually curve backward, and they alternate with the second kind, which he called intermediate teeth (Zwischenzähne). These are very minute, triangular in shape, and they occupy the base of the angles between the principal teeth. The third kind were called secondary teeth (Nebenzähne), and they are found in a continuous row behind the principal teeth. They are much smaller than the latter and diminish rapidly in size from in front backward. The mandibles in the genus *Naobranchia* (Kurz's *Cestopoda*), and rarely in the males of other genera, have no intermediate teeth, and the other two kinds are often so nearly of the same size that it is hard to distinguish them.

The mandibles are operated as follows: The base being inserted in the fold of skin outside the proboscis holds the appendage rigidly in position, with its toothed tip at the opening of the proboscis, the two mandibles almost or just touching, and the two rows of teeth facing each other. The proboscis is then thrust against the skin of the host and the marginal fringe is flattened out, laying bare the tips of the mandibles. These are pushed into the skin far enough for the teeth to get a good hold. The mandibles are then drawn back into the proboscis by means of powerful retractor muscles (*rm*, fig. 3), which run from the base of each mandible backward and outward and are fastened to the side wall of the head. As the base of the mandible is pulled by this muscle the skin fold in which the mandible is inserted is turned inward like the end of a glove finger. The withdrawal of the mandibles also brings the fold of the host's skin, in which their teeth are caught, up into the mouth opening. Here the skin is further lacerated by a sawlike motion until the blood flows freely. During retraction the mandible is also twisted through an angle of 90° upon its long axis, as was first discovered by Kurz. This brings the teeth around, so that instead of facing each other, as at first, the toothed portions of the mandibles both point in the same direction—ventrally. This flexion, after the mandibles have been thrust into the skin of the host, gives them a better hold and keeps the wound open so that the blood will flow freely. The maxillipeds, and in some species the second antennæ, are also inserted in the host's skin and help to hold it up against the mouth tube.

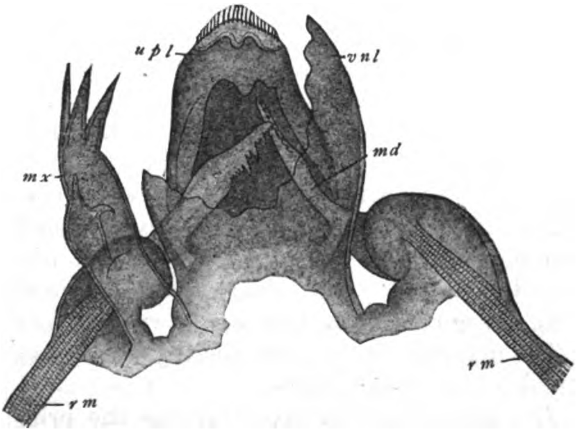


FIG. 3.—MOUTH-PARTS OF LERNAEOPODA GALEI (ACHTHERES SELACHIORUM KURZ). *md*, MANDIBLE; *mx*, FIRST MAXILLA; *rm*, RETRACTOR MUSCLE OF MANDIBLE; *upl*, UPPER LIP; *vnl*, UNDER LIP. THE MANDIBLE ON THE RIGHT SIDE OF THE FIGURE HAS BEEN RETRACTED AND TWISTED THROUGH AN ANGLE OF 90°.

The first maxillae (*mx*, fig. 3) are very rudimentary and palplike and contain no chitin, but are soft and flexible like the first antennae. They have been variously interpreted by different authors, the most of whom have called them palps and have connected them with the second antennae or the mandibles. But Kurz proved conclusively that they are appendages of the same rank as the antennae and mandibles; that they have no connection with either, but are moved by an entirely independent set of muscles, and that in the majority of instances they are themselves furnished with a very respectable palp. Furthermore, it was found by the present author[1] that these appendages are innervated by a separate nerve from the infra-esophageal ganglion, which adds the final touch to the proofs already accumulated. Their position is on the sides of the proboscis, close to its base and much nearer the ventral than the dorsal margin, and they do not usually reach beyond the mouth opening. Their general form is narrow and cylindrical, slightly contracted at the base where they join the proboscis, and divided at the tip into two or three fingerlike rami, each of which terminates in a stout and acuminate soft seta. At or near the center, on the ventral surface and at the inner margin, each maxilla gives off a palp, which is usually divided at the end, like the maxilla itself, into two or three fingerlike processes, each armed with a soft seta. There is no genus in which the maxillae show definite segmentation, but they always appear one-jointed.

The maxillae in the male correspond very closely with those of the female of the same species.

The second maxillae have become the principal organs of attachment in the present family, and accordingly we find them modified in various ways to serve this function. When they first appear in the metanauplius stage they are clawed appendages, similar in all respects to the maxillipeds. In the free-swimming or first copepodid stage, when the larva attaches itself to its host or shortly afterwards, these second maxillae are fastened to the proximal end of the frontal filament. In the female this union of maxillae and filament becomes permanent throughout life, and the two fuse thoroughly until all that is left of the filament is the button or bulla which joins the tips of the maxillae and serves to anchor them firmly in the tissue of the host. No such union takes place in the male and his second maxillae remain clawed appendages, very similar to the maxillipeds.

In the female, after the fusion of the maxillae and filament, the former lose their claws and all traces of segmentation. Even the internal muscles are entirely changed and become longitudinal bundles running the whole length of the appendage without a break. This length varies greatly in the different genera and furnishes, with other coordinate differences, excellent generic characters as already noted (see p. 573). In one species, *Lernaeopodina longimana,* the arms, as these transformed second maxillae are called, are as slender as threads and fully three times the length of the entire body. On the other hand some species of *Clavella* have no arms at all; they have entirely disappeared and the attachment bulla is sessile upon the ventral surface of the body. Yet even in these species we find the remains of the maxillary muscles arranged in pairs on either side of the sessile bulla. Between these two extremes there is almost every gradation.

---

[1] Proc. U. S. Nat. Mus., vol. 39, pl. 34, fig. 33.

The arms are usually separated to their tips, where they are united to the pedicel of the bulla. In the genus *Clavella,* however, the arms are fused together more or less, sometimes for their entire length. When they first appear these second maxillae are on the head and in front of the maxillipeds, but during subsequent development the two usually exchange places. The second maxillae then migrate onto the first thorax segment and may move a long distance behind the other mouth parts (*Clavellisa, Brianella,* etc.).

The bulla is composed of the hardened secretion of the frontal gland and is usually mushroom-shaped, but may be club-shaped (*Basanistes, Salmincola thymalli*), button-shaped (*Clavellopsis sargi, Brachiella triglæ*), funnel-shaped (*Clavellopsis fallax*), goblet-shaped (*Brachiella hostilis*), star-shaped (*Tracheliastes stellifer*), or even flattened out like a plate (*Salmincola inermis*). The way in which this bulla is fastened to the host has already been described.[1]

There is one thing to be added which was also noted by Kurz. The viscid secretion which fastens the bulla to the skin of the host acts as an irritant and causes the skin to fester and swell into a wall or fold, which rises up around the bulla and finally entirely envelops it. This adds greatly to the security of the attachment; in fact the only way in which the parasite can be detached is by dissecting out the bulla, which usually proves to be a difficult process. We should also notice the peculiar muscle bands which serve as second maxillae in *Naobranchia,* and the unique sucking disks just outside the base of the maxillipeds (see p. 662).

The maxillipeds.—These are clawed appendages, similar to those found in all the copepod families. They consist of a powerful basal joint well supplied with strong muscles, which operate the terminal claw and flex it down against the inside of the basal joint. The claw is usually straight or slightly curved, and is often reinforced near the tip by a short spine or secondary claw.

The inner surface of the basal joint, against which the claw shuts, is also roughened and armed with various teeth, processes, spines, etc., to increase the firmness of the hold. In the male the claw is usually curved more than in the female, and in *Thysanotella*, if Bassett-Smith's figure be correct, it describes three-quarters of a circle. These maxillipeds in the female have lost their function of attachment organs, and are used only for pulling the head down to the skin of the host and holding it while the parasite gets its food. In *Tracheliastes* even this function is lost, and it is difficult to understand how they can be used at all, situated as they are between the bases of the second maxillae (see plate 40, fig. 106).

---

[1] Proc. U. S. Nat. Mus., vol. 39, p. 211.

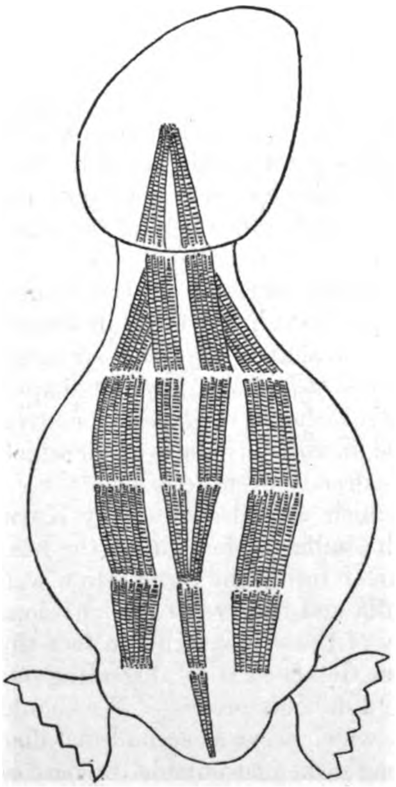


FIG. 4.—DORSAL MUSCLES OF ACHTHERES AMBLOPLITIS.

The muscular system.—This is extremely simplified, and is as much reduced as is possible consistent with retaining any power of motion. We may divide the musculature of the adult female as follows:

1. *Dorsal muscles.*—Along either side of the median line of the dorsal surface are two bands of longitudinal muscles, the outer band considerably wider than the inner one (fig. 4).

These bands are curved lengthwise, being farther apart at the center and closer together at the ends. The four bands are each broken at the points which represent the dividing lines between the different body segments, and thus furnish the best, and in some genera (*Basanistes*, *Clavella*, etc.) the only, evidence of segmentation. According to this evidence the body of the female of *Achtheres* is made up of a cephalothorax, which is a fusion of the head and first thorax segment, and a trunk, which is made up of three thorax segments, a genital segment, and a one-segmented abdomen. The inner pair of muscle bands start from a common point of attachment at about the center of the dorsal surface of the cephalothorax. They diverge until they reach its posterior margin, run approximately parallel through the second and third thorax segments, and converge in the fourth segment, meeting again at its posterior margin. In the genital segment and in the abdomen there is but a single fused muscle band along the median line. A similar fusion takes place on the ventral surface, this time between the components of the right and left pairs.

The outer pair of dorsal muscle bands start also from a common point of attachment in what may be called the throat of the parasite on the ventral surface of the first thorax segment, just behind the mouth parts. They run upward toward the dorsal surface and rapidly outward, so that at the posterior border of the second segment each is outside of the inner pair. They then run backward outside of the latter and parallel with them as far as the posterior border of the genital segment, where they abruptly cease.

2. *Ventral muscles.*—Four similar bands run along the ventral surface, but with these differences; they start side by side at the anterior border of the second thorax segment, diverge a little, then converge, and end abruptly at the posterior margin of the genital segment. Instead of the median pair being fused it is the two on either side of the median line which are partially fused in the fourth segment and completely fused in the genital segment (fig. 5).

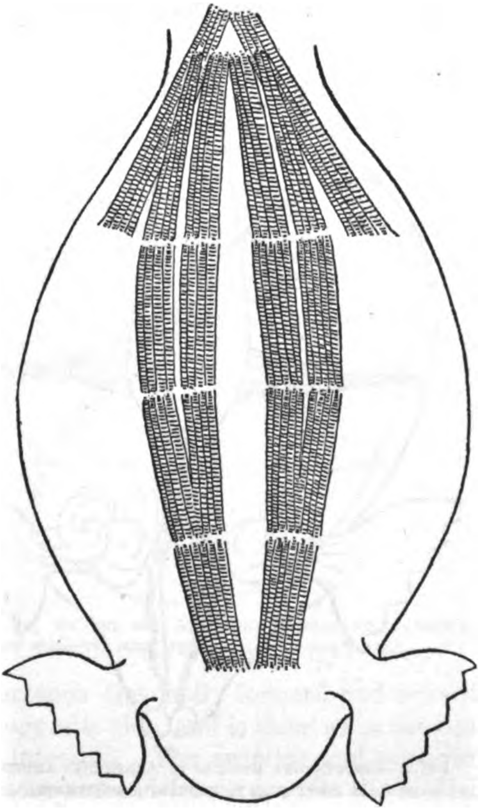


FIG. 5.—VENTRAL MUSCLES OF ACHTHERES AMBLOPLITIS.

3. *Muscles of the second maxillae.*—During the copepodid stages these appendages are two-jointed and furnished with claws, and the muscles are arranged like those of other two-jointed appendages. But after fixation to the host and the subsequent fusion of the second maxillae with the attachment filament the jointing in these appendages is lost. And in place of the original musculature we now find two bands of muscles running the entire length of the appendages without a break, even though that be three times the length of the entire body (*Lernaeopodina longimana*).

In those genera like *Clavella*, where the second maxillae are often lacking, leaving the attachment bulla on the ventral surface of the thorax, we still find the rudiments of a pair of longitudinal muscles, which represent the original appendages.

Similarly in those species in which the second maxillae are united throughout their entire length these longitudinal muscles remain separate and thus witness to the paired origin of the attachment organs.

4. *Muscles of the other appendages.*—The mandibles and first maxillae are each supplied with the usual muscles. The one attached to the base of the mandible (*rm*, fig. 3) is a powerful retractor, which not only draws the mandible back into the proboscis tube but also turns it sidewise, so that the toothed edge points ventrally. There may be either one or two muscles connected with the base of the first maxillae, but the amount of motion they produce is very slight. The maxillipeds are provided with the usual muscles found in such two-jointed appendages, those designed for the flexion of the terminal claw being usually very powerful. The muscles of the first and second antennae also produce but little motion; these appendages are often very obscurely jointed and the musculature then gives the most reliable information as to the number of joints. In some genera (*Basanistes*, etc.) the second antennae are exceptionally developed and are furnished with the musculature necessary to enable them to function as organs of prehension. The mouth tube is also furnished with muscles by means of which it can be directed and held against the skin of the host or withdrawn at pleasure.

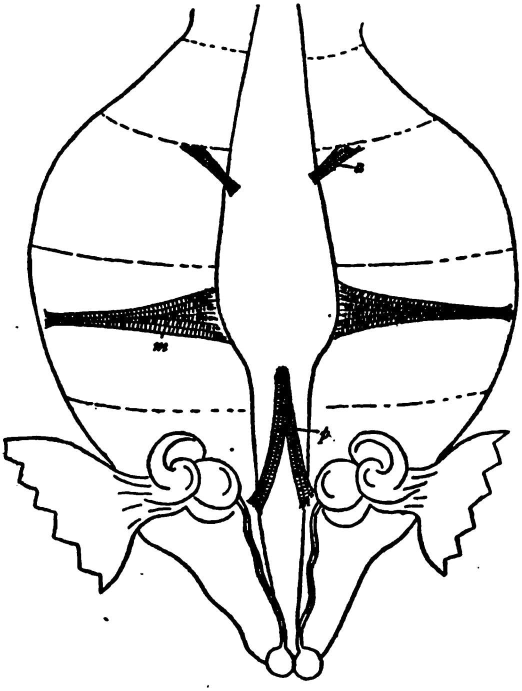


FIG. 6.—CIRCULATORY MUSCLES OF ACHTHERES AMBLOPLITIS. *a*, ANTERIOR; *m*, MEDIAN; *p*, POSTERIOR.

5. *Special muscles.*—In addition to the muscles already enumerated there are others which serve specific purposes and which consequently deserve particular notice. The first of these may be termed the circulatory muscles, since it is through their contraction and relaxation that the meager circulation in these parasites is maintained. There are three pairs of them, an anterior pair in the third thorax segment, a median pair in the fourth segment, and a posterior pair in the fourth

and fifth segments. The anterior pair (*a*, fig. 6) are short and cylindrical and each originates in the groove separating the second and third thorax segments on the dorsal surface about half way from the lateral margin to the midline. It then runs diagonally inward and backward and is inserted in the side of the digestive tube, a little above the center.

The median pair (*m*) are strongly flattened dorso-ventrally; each originates at the center of the lateral margin of the fourth segment, extends directly inward, and is inserted in the wall of the stomach; it is narrow at its origin but widens out greatly at its insertion. The posterior pair (*p*) are cylindrical again; each originates on the dorsal wall of the genital segment, extends diagonally forward and inward, fuses with its fellow from the opposite side, and is inserted in the center of the dorsal wall of the intestine. The anterior and posterior pairs pull the digestive tube backward and forward, while the median pair pull it to the right or left.

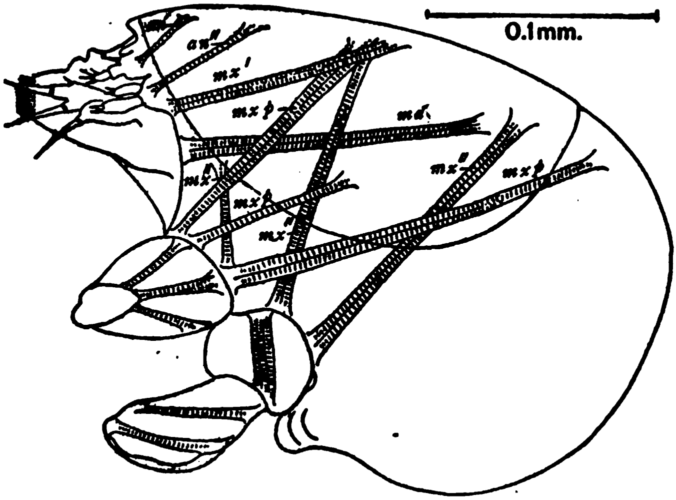


FIG. 7.—THE MALE OF CLAVELLISA CORDATA. *an'* AND *an''*, ANTENNAL MUSCLES; *md*, MANDIBLE MUSCLE; *mx'* and *mx''*, MAXILLARY MUSCLES; *mxp*, MUSCLES OF THE MAXILLIPED.

Another pair of special muscles may be called the ejaculatory muscles; they are situated on the dorsal surface of the semen receptacle in the genital segment (*em*, fig. 8). Each extends from the thickened margin of the external opening of the oviduct diagonally inward and backward to the center of the dorsal surface of the sperm receptacle. A contraction of these muscles aids in forcing the eggs out into the external sacks, and may at the same time help to discharge the contents of the sperm receptacle.

6. *The musculature of the male.*—In those males in which the cephalothorax and trunk are either in the same line (*Achtheres*, etc.) or somewhat flexed without any fusion (*Brachiella*, etc.) the general

scheme of musculature is similar to that of the female. But where there is not only flexion but also complete fusion (*Clavella*, *Clavellisa*, etc.) the musculature is entirely changed. We no longer find any dorsal and ventral body muscles, or any special respiratory muscles, but all the movements of the body are accomplished by means of muscles connected with the appendages. The male of *Clavellisa* may be taken as an example (fig. 7). The muscles of the left side only are given in the figure, and it is to be understood that each is duplicated on the right side. It will be noted that there are single muscle strands connected with the first and second antennae (*an'*, *an''*), larger and more powerful single muscles connected with the first maxillae (*mx'*) and the mandibles (*md*), while there are three stout muscles attached to each second maxilla (*mx''*) and maxilliped (*mxp*). Each of these muscles is inserted in the base of the appendage to which it belongs and runs diagonally into the body to its origin, somewhere on the dorsal or lateral walls.

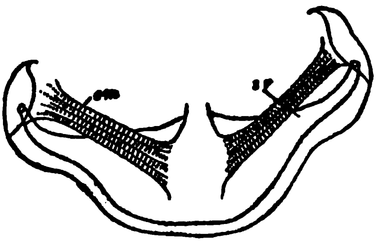


FIG. 8.—DORSAL VIEW OF EJACULATORY MUSCLES (*em*) AND SPERM RECEPTACLE (*sr*) OF ACHTHERES AMBLOPLITIS.

All the necessary motions in the male are accomplished by these appendage muscles. In these pigmy males, therefore, the last vestige of segmentation, namely, the interrupted longitudinal muscle bands, has completely disappeared.

RESPIRATION.

There is in this family nothing which resembles, or functions as, a respiratory organ; there is not even the opening and closing of the anus and rectum (anal respiration) so prevalent among the free-swimming forms and in the Caligidae and Ergasilidae.

In the female there are no oblique muscles attached to the sides of the rectum, and in the male there is no anal opening, so that such a method of respiration is impossible in both sexes.

Apparently the only means of aërating the blood is through the body walls, which are comparatively thin. Furthermore the demands for aëration have been reduced to a minimum in these parasites, who have lost all freedom of motion, whose food is very easy to digest, and whose circulation is extremely crude.

CIRCULATION.

There is no heart nor any blood vessels in the Lernaeopodidae; there are not even any lacunae through which the blood might flow. The body is virtually a bag, in the cavity of which are suspended the various organs, while the spaces around them are entirely free, and every part is in direct communication with every other part. The blood moves about freely through these open spaces and a sort of circulation is accomplished by a rhythmic contraction of the three pairs of special muscles already described (see p. 584). The muscles in each pair contract alternately and pull the intestine away from the midline, now toward the right side and now toward the left, or forwards and backwards. When the intestine is pulled to the right the blood on that side of the body is pushed precipitately forward into the head. At the same time on the left side of the body the blood streams backward from the head to fill up the space formerly occupied by the intestine. These motions are reversed when the intestine is pulled to the left, and this backward and forward streaming constitutes all the circulation.

The strong peristaltic movements of the stomach and intestine help to push the blood along if it lies in contact with the wall of the digestive tract. We have used the term blood here, but of course it can bear that name only by courtesy. It is not really blood like that found in the Argulidae, Caligidae, and Chondracanthidae, but is simply the liquid which fills the body cavity. It has no corpuscles but may serve to distribute the oxygen absorbed through the body walls.

In the male there is not even this apology for a circulation, and in all those which have been examined there has never been observed a streaming of the liquid contents of the body in any direction. The body of the male is reduced to such a small size that probably enough oxygen can be obtained by direct absorption through the body walls.

THE DIGESTIVE SYSTEM.

In the present family this consists of a mouth, an esophagus, a stomach, and an intestine. The mouth-tube is turned forward and is the most anterior part of the body, with the mouth-opening at its tip. The structure of the mouth and the mode of filling it with blood have already been described (see p. 577).

There are no glands connected with the mouth and the only use it serves is as a funnel to guide the blood into the esophagus, which is slender and thread-like and almost straight (fig. 122).

It passes abruptly into the enlarged stomach, a thick sphincter muscle being found at the point of junction. This latter is in the head and about on a level with the bases of the maxillipeds, even in those genera (*Clavella*, *Clavellisa*, etc.) which have very long necks. In such genera most of the stomach, and by far the most important part, is located in the neck. The stomach passes so insensibly into the intestine that it is impossible to distinguish any point of separation. Both stomach and intestine possess thick walls made up of an outer serous membrane, a median muscular layer, and an inner glandular layer. The latter contains many modified cells, which are filled with a digestive fluid, and thus take the place of digestive glands. In the long-necked genera that portion of the stomach, if any, which enters the trunk is narrowed and flattened and so crowded by the reproductive organs that it functions only as an intestine.

THE EXCRETORY SYSTEM.

In the Lernaeopodidae the excretory system is made up of two pairs of glands. The maxillipedal pair are on the dorsal side of the body, behind the bases of the maxillipeds. Each starts at three different centers, one median and two lateral, which increase in size and gradually fuse together. A spirally convoluted duct leads to the base of the maxilliped where it opens to the surface. The maxillary pair are situated at the bases of the second maxillae; a straight duct leads from each gland outward and opens on the inner surface of the maxilla (fig. 141).

In those genera (*Clavella*, *Clavellisa*, etc.) where the second maxillae have disappeared and the bulla is on the ventral surface of the trunk, the maxillary glands have migrated into the trunk and can be found on either side of the bulla. This is also the case in *Naobranchia* where the second maxillae are present but are so modified that they can not contain the glands (p. 661).

In many species also, of various genera, the second maxillae are so slender and their inner cavity is so filled with the longitudinal muscles that there is little room left for the glands. In such species there is often a swelling on the outer surface of the maxilla near its base, and in this swelling is located the gland (fig. 221). Or the swelling may be on the side of the neck near the base of the second maxillae (fig. 109.)

THE NERVOUS SYSTEM.

The nervous system[1] consists of a very large infra-esophageal ganglion and an equally small supra-esophageal ganglion (fig. 122). From the anterior end of the latter two pairs of nerves are given off, one of which goes to the first antennae and frontal margin, while the other larger pair supply the second antennae and upper lip. From the posterior end a third pair of nerves run backward along the anterior walls of the stomach, the dorsal portion of the head, the frontal gland, and the maxillipedal gland.

From the anterior end of the infra-esophageal gland a pair of nerves run forward to the base of the lower lip and send a branch to the mandibles. From the ventral surface of this ganglion a slender nerve goes to the first maxilla on either side, another to the second maxilla, and from the postero-ventral corner a larger nerve runs to the maxilliped. Just in front of this last nerve a delicate nerve thread runs diagonally to the sides of the maxilli-pedal and maxillary glands. At the posterior corner of the ganglion a slender nerve extends backward along the ventral walls of the stomach and close to its fellow from the other side. These nerves show no ganglionic swellings and no ganglion cells. The nervous system is thus practically concentrated in the infra-esophageal ganglion.

---

[1] Good figures of the nervous system of both sexes were published in these Proceedings—vol. 39, plate 34.

THE REPRODUCTIVE ORGANS.

The reproductive system in the female consists of paired ovaries and oviducts, an unpaired sperm receptacle, and paired cement glands. In the male it consists of paired testes and vasa deferentia, and paired spermatophore receptacles.

The ovaries and testes lie in what may be termed the small of the back, between the stomach and the dorsal body wall. From the posterior ends are given off the oviducts and vasa deferentia which run around the stomach to the ventral surface, and then backward to the openings in the sides of the genital segment.

In both sexes these ducts become so convoluted and swollen at maturity that they fill the entire cavity on either side of the digestive tract, which is flattened laterally into a mere slit.

The sperm receptacle in the female lies in the posterior portion of the trunk, sometimes dorsal and sometimes ventral to the intestine. In those genera (*Achtheres*, etc.) which have an abdomen the receptacle is dorsal and consists of a bag nearly twice as long as wide, placed transversely in the trunk and flattened dorso-ventrally. Each end of the bag is prolonged at the anterior corner into a slender tube which runs outward to the oviduct and opens into the latter just inside of its external opening; at the posterior corner into a canal, the vagina, which leads diagonally backward and inward to the posterior margin of the abdomen, where it opens to the exterior alongside the midline. In those genera (*Clavella*, etc.) which have no abdomen the sperm receptacle is ventral to the intestine, is not as long as in *Achtheres*, and the vaginae are usually more or less fused. They run back through the genital process and open at its tip, either closely side by side or, if fused, in one common opening.

When the spermatophores are fastened by the male upon the abdomen or genital process of the female their tubes enter these external openings (vulvae). And the spermatozoa which they contain are discharged through the vulvae and vaginae into the receptacle. In the present family there is no crossing of the tubes of the spermatophores, as in the Caligidae, but each spermatophore empties into the vagina on its own side of the body (fig. 8, p. 586). Even in those genera where the vaginae are fused and have a common vulva the spermatophore tubes are still uncrossed.

When once filled the sperm receptacle holds enough to fertilize all the eggs the female will ever lay. Whenever an egg is sufficiently matured it passes down the oviduct and out into the external cases. As it passes the opening of the sperm tube it is fertilized, and this individual fertilization is responsible for the remarkably small number of eggs that fail to develop. The cement glands are very large and in *Achtheres* fill the entire sides of the thorax segments in front of the genital segment. Each is crescent-shaped, its outer convex surface fitting snugly inside the lateral body wall, while its inner surface is nearly straight. It consists of three parts, separated by well-defined constrictions. The anterior, terminal portion (*t*) is about one-quarter of the entire length and is filled with a fine-grained matrix out of which is formed the cement substance. This is the real glandular portion where secretion is carried on. The central half (*c*) is a little broader than the terminal portion and is somewhat flattened dorso-ventrally; its wall is transversely striated and must contain muscle fibers since it is more or less contractile. It is evidently used for the storage of the cement substance until the eggs have fully ripened (fig. 9).

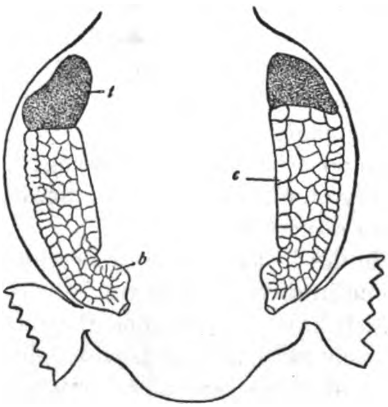


FIG. 9.—CEMENT GLANDS OF ACHTHERES AMBLOPLITIS. *b*, BASAL PORTIONS; *c*, CENTRAL; *t*, TERMINAL.

The posterior basal portion (*b*) forms the duct or tube through which the cement substance passes out into the oviduct. It has a sharp curve or bend on its inner margin around which the tube passes and which acts as a sort of valve to regulate the flow. The cement glands of all the other genera in which they have been observed are similar to those of *Achtheres*.

In the male the vasa deferentia lead around the side of the stomach to the ventral surface, swing back again to the dorsal surface, run diagonally backward to the center of the lateral surface, turn a little toward the dorsal surface, and finally pass diagonally backward to the opening on the ventral surface of the genital segment. The swollen anterior portion of these convolutions is a combination of cement gland and vas deferens, the fine-grained gland cells secreting the viscid substance which composes the covering of the spermatophore. The posterior portion in the adult male is enlarged into a receptacle within which the spermatophores are gradually matured and filled with spermatozoa (compare fig. 198).

ONTOGENY.

The complete life history of *Achtheres ambloplitis* has already been published.[1]

Fasten has also given us an account[2] of the free swimming larva of *Salmincola edwardsii*. Some of these copepodid larvae, admirably mounted, were loaned to the present author for study and comparison, and have proved of great value.

It only remains, therefore, to restate the life history very briefly, and to compare the larvae of the two genera above named with those of *Clavella*, the material for which is here presented for the first time. Inside the ovary are many long filaments, which are connected with the older oocytes and whose terminal cells develop successively one after the other. In *Clavella uncinata* (fig. 10) these filaments are given off dorsally and pass down ventrally into the convolutions of the oviduct, where the end cells can be seen in various stages of development. These filaments are longer and less convoluted in *Clavella* and *Clavellisa* (fig. 11) than in *Achtheres* or *Naobranchia* (fig. 12). They stain readily and in double-stained sections always show a dark purple color. A vitelline membrane is visible around the end cell, even before it separates from the filament. Inside of this membrane the entire substance of the egg is made up of yolk globules evenly distributed through a fine matrix of protoplasm. Scattered about are numerous large vacuoles of different sizes, those nearest the periphery being usually the smallest. As the eggs pass down the oviduct they are each fertilized at the opening of the sperm tube, and are covered with a layer of the cement substance before they pass out into the external sacks. In the latter they segment, and the larvae develop through the nauplius and metanauplius stages before hatching. Segmentation is entirely superficial, the cytoplasm separating from the yolk, migrating to the surface and there forming blastoderm cells around nuclear centers. The yolk remaining inside the egg and afterwards inside the embryo serves to nourish the latter not only through the nauplius and metanauplius stages but also through the free swimming copepodid stage. Since neither the nauplius nor the metanauplius can escape from the egg, their unfolding is necessarily condensed. Usually the three nauplius appendages develop and serve their temporary function before the other appendages

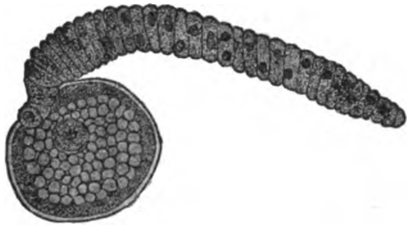


FIG. 10.—EGG FILAMENT AND DEVELOPING EGG IN CLAVELLA UNCINATA.

---

[1] Proc. U. S. Nat. Mus., vol. 39, p. 189.

[2] Report of the Commissioners of Fisheries of Wisconsin, 1911-12, p. 11.

appear. But here in the Lernaeopodidae the mouth parts and the first two pairs of swimming legs appear simultaneously with the nauplius appendages, and they all develop together. The early larval stages are thus so thoroughly fused as to become virtually one single period, and the peculiarities which characterize the different stages overlap one another, several sometimes being present at the same time.

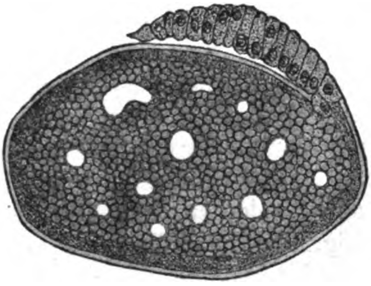


FIG. 11.—EGG FILAMENT AND DEVELOPING EGG OF CLAVELLISA CORDATA.

Understanding such a fusion, therefore, we may distinguish the following steps in development by dissecting some of the larvae out of their surrounding envelopes.

Nauplius.—Body ovate, the larger end anterior; two pairs of appendages visible, corresponding to the first and second antennae; first pair one-jointed, uniramose, terminating in two plumose setae; second pair biramose, exopod five-jointed, each joint with a long plumose seta, endopod two-jointed and terminated by two plumose setae; no balancers but the posterior portion of the body differentiated into a free thorax and a broad spatulate abdomen, which is curled over ventrally beneath the thorax; no eye visible but the anterior part of the head occupied by an attachment filament which forms a simple loop, extending from the frontal margin to the center of the head; behind this may be seen the yolk granules and on either side are the muscles that later will move the swimming legs.

Metanauplius.—Body so thick and stout as to be nearly spherical; first antennae three-jointed and tipped with two plumose setae; second pair with a five-jointed exopod, each joint with a plumose seta, and a two-jointed endopod, with two terminal setae and a stout claw at their base; upper lip elliptical, wider than long; mandible short, uniramose, and tipped with a single seta; first maxillae biramose at the tip, the outer ramus much shorter than the inner, and each armed with short spines; second maxillae stout, uniramose, three-jointed and terminated by a weak claw; maxillipeds also uniramose and three-jointed and terminated by a stouter claw.

FIG. 12.—EGG FILAMENT AND EGG OF NAOBRANCHIA LIZAE. FIGS. 10, 11, AND 12 ARE MAGNIFIED ALIKE.

Each of the four swimming legs consists of a basal joint and two one-jointed rami, armed with long plumose setae; the anal laminae are as large as the rami of the legs and carry long and unequal setae. The first actual molt takes place at the close of this metanauplius stage, and the escape from the egg is simultaneous with it.

First copepodid or free-swimming stage.—Body elongated, flattened dorso-ventrally and made up of a cephalothorax, three free thorax segments, and a fused genital segment and abdomen, carrying the anal laminae. The cephalothorax is a more (*Clavella*) or less (*Achtheres* and *Salmincola*) complete fusion of the head and first thorax segment. In the latter genera the separation of the two is indicated by notches on the lateral margins and by a dorsal groove; in the former genus these do not appear. The shape of this cephalothorax is elliptical in *Salmincola*, ovate in *Clavella*, and elliptical or subquadrilateral in *Achtheres*. A characteristic copepod eye is found at about the center of the cephalothorax in *Clavella* and *Salmincola*. The eye in *Achtheres* is so rudimentary that it can not be seen except in sections. In the front of the head, close to the dorsal surface, lies the attachment filament which is characteristic of this family. It consists of a long cylindrical rod, enlarged at either end; the enlargement of the distal end is in the shape of a mushroom or umbrella, and is the part that sticks to the flesh of the host, and becomes the bulla or attachment organ of the adult parasite. The cylindrical rod is folded in a single loop in *Salmincola*, coiled like a rope in *Achtheres*, and wound into a tight spiral in *Clavella* (fig. 13).

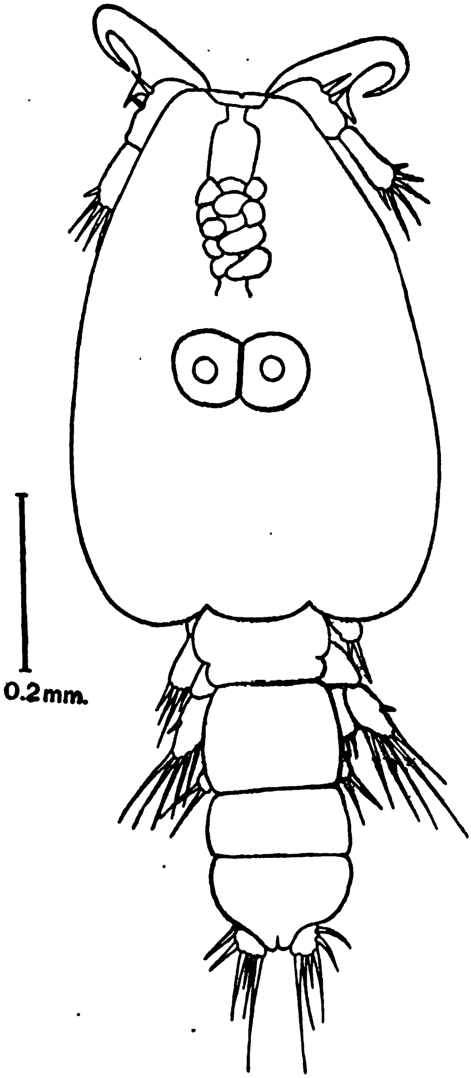


FIG. 13.—COPEPODID LARVA OF CLAVELLA UNCINATA.

The first thorax segment is two-thirds as large as the head, is fused with the latter, and tapers posteriorly, terminating in two large lobes which correspond to the posterior lobes of the carapace in the Caligidae. The second (first free) thorax segment is much larger than the segments which follow it in *Achtheres* and *Salmincola*, but is the same size or a trifle narrower in *Clavella*. The third and fourth segments are about the same size and length in all the genera, but their relative size compared with the cephalothorax or with the second segment varies greatly. In general they are very narrow in *Achtheres* and *Salmincola* and very wide in *Clavella*. The last segment is a fusion of the posterior portion of the thorax and the abdomen, and it carries the anal laminae, which are variously armed with setae in the different genera. The first antennae are four-jointed and extend directly outward at right angles to the body axis in *Salmincola* and *Achtheres*; in *Clavella* they apparently have fewer joints and are turned backward along the sides of the carapace. The second antennae are biramose, the exopod one-jointed and tipped with a single seta, the endopod two-jointed and ending in a powerful hooked claw. The mouth-tube projects downward and forward from between the bases of the second antennae. It is made up of an upper and under lip, the latter grooved and fluted, overlapping the edges of the upper lip, and consisting of two halves, which are often not entirely fused. The mandibles are outside the base of the mouth-tube, one-jointed and tipped with short setae; the first maxillae are also uniramose but two-jointed and tipped with longer setae; the second maxillae are stout, two-jointed, and tipped with a long and slender claw, bent into a half circle; the maxillipeds are also stout, three-jointed, and tipped with a stouter and straighter claw (fig. 14). Swimming legs biramose, the basal joints broad and laminate, and furnished with powerful muscles, the rami small, one-jointed, and armed with long plumose setae (fig. 15).

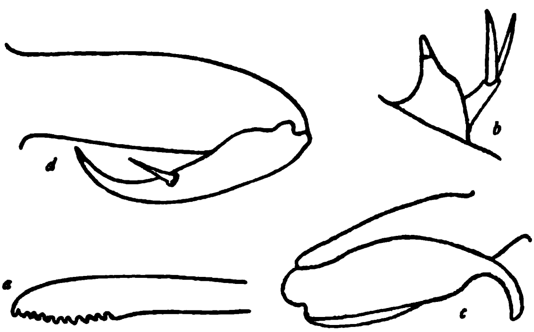


FIG. 14.—COPEPODID LARVA OF CLAVELLA UNCINATA. *a*, MANDIBLE; *b*, FIRST MAXILLA; *c*, SECOND MAXILLA; *d*, MAXILLIPED.

As soon as this copepodid larva escapes from the egg it begins an active search for a host. By means of its two pairs of swimming legs it moves about actively in a more or less spiral path.[1] This movement is kept up for 24 to 48 hours, and then relaxes, the larva becoming so wearied that it can scarcely move at all. Consequently it must find a host within this time or perish; if it is fortunate enough to come in contact with the right kind of fish it fastens itself at once to it. It is a general rule that every species of fish has its own peculiar parasites, and hence the latter must have some means of selecting the right host. It is also true that the more fixed the parasite becomes and the less capable it is of moving about, the more exclusively is it confined to one species of fish.

---

[1] Fasten, Journ. Animal Behavior, vol. 3, 1913, p. 43.

It is only the free-swimming forms like *Argulus* and some of the Caligidae that have a long list of hosts. Eyesight probably has very little to do with the selection of the particular host, especially in the present family, where the eyes are so rudimentary as to be practically useless.

Fasten's experiments with *Salmincola edwardsii*, together with repeated observations by the present author, would indicate that the choice is made by some chemical means, smell or taste, or a combination of the two. Actual attachment is accomplished by bringing the frontal margin of the head in contact with the skin, fin, or gill of the host. The mushroom end of the attachment filament then sticks fast, and the filament is withdrawn from the head. In *Salmincola*, according to Fasten, the larva remains a short time attached by the frontal filament; in the other genera such an attachment has not yet been observed. But in any case this attachment lasts only a short time; the proximal end of the filament is grasped by the second maxillae and detached from the frontal margin of the head. The maxilla and filament are then thoroughly fused, and remain as the so-called arms or permanent attachment organs of the adults of this family of parasites. There is always an absorption of the filament, and there may be also an absorption of the maxillae until all that is left of the original apparatus is the distal mushroom enlargement of the filament, the bulla, buried in the flesh of the host. Many species of *Clavella* show such a condition, the bulla being fastened directly to the ventral surface of the trunk. On the other hand, after the filament has been absorbed the arms sometimes lengthen until they may become two or three times the length of the entire body, as in *Lernaeopodina*.

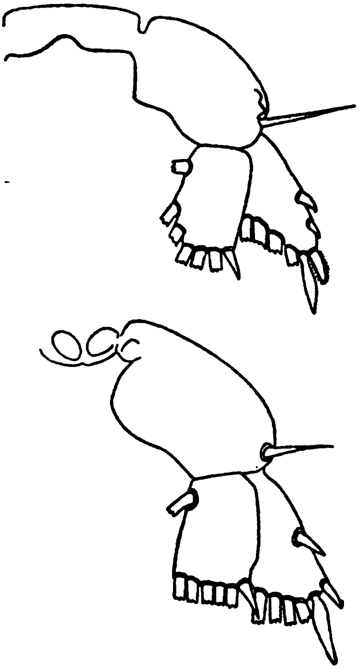


FIG. 15.—FIRST (UPPER) AND SECOND SWIMMING LEGS OF COPEPODID LARVA OF CLAVELLA UNCINATA.

The male does not become permanently attached in this way, but retains his hold on the filament for a short time only and then lets go and clings to the body of the female for the rest of his life. Subsequent to attachment the changes which take place in the copepod are chiefly concerned with the development of the reproductive organs. In the fixed female the legs, the segmentation of the body, and frequently the anal laminae disappear. At the same time the trunk or so-called genital segment increases through the development of the convolutions of the oviducts and becomes relatively as well as actually much larger than before, and finally the external egg sacks are formed, which may be regarded as the completion of the life cycle.

The male does not increase much in size, but remains a pygmy; he usually loses the two pairs of swimming legs, but retains, in part at least, the body segmentation. The maturing of the spermatophores and their subsequent attachment to the genital process of the female marks the completion of his life cycle, and he does not probably live very long afterwards.

SYSTEMATIC.

Historical.—In the first edition (1735) of his Systema Naturae Linnaeus placed all the crustaceans among the wingless insects under three genera. It is very doubtful if any member of the present family was included in this first edition. But later in the second edition of the Fauna Suecica (1761) he described *Lernaea salmonea,* which is really a Lernaeopod and probably the oldest member of the family, and which he located among the mollusks.

Having thus begun under the genus *Lernaea,* the present family was for a long time included with the Lernaeidae. On account of their degenerate form they were not placed with the crustacea by any of the earlier zoologists. Lamarck, after locating them among the mollusks (1801) and the annelids (1809) went so far as to create a separate group to receive them (1812) which he called the Epizoaria and placed between the worms and the insects. In his Handbuches der wirbellosen Thiere (1816) he writes that he had found Lerneans which showed a transition from insects to worms so that the Epizoaria could be regarded only as a provisional or temporary class.

Bosc, also following Linnaeus, placed them among the mollusks (Historia Vermium, n. d.), but contended that they were closely related to the intestinal worms. Oken, in his Lehrbuch der Naturgeschichte (1815–16), included some of the Lernaeopodidae in two different places. First he placed among the worms (pp. 182–184), between *Echinorhynchus* and *Hamularia,* the genera *Philline, Schisturus,* and *Lernaea.* Second as a separate group, the Armwürmer (pp. 357–359), between *Asterias* and *Gordius,* he placed not only *Axine, Clavella, Pennella,* and *Lernaea,* but also *Dichelesthium, Caligus,* and *Argulus*. But while locating them thus wrongly, he at the same time pointed out their close relationship to the Entomostraca, and thus made a notable advance over his predecessors. De Blainville published in the Bulletin des Sciences, Paris, 1816, a new classification of the animal kingdom in which he placed the Lernaeopodidae with other copepod parasites, in a subclass Epizoaires under the class Tetradecapods and the group Articulates. Later he made a special study of the Lernaeidae and gave (Journal de Physique, 1822) the first good account of their anatomy. He divided the family into a large number of new genera, which he arranged according to their morphology and the nearness with which they approached *Caligus*. The seventh of these was the new genus *Lernaeopoda*, the type of the present family. Latreille in Cuvier's Règne Animal keeps the Lernaeans among the intestinal worms even as late as 1830.

He admits that other authors have claimed that these parasites are crustacea, as is shown by the mâles, but he adds, "pour consacrer cette opinion, il foudrait pouvoir rétrouver ces mâles" (vol. 3, p. 256).

He introduces with Oken's *Clavella* the new genera *Anchorella* and *Brachiella*, which belong to the Lernaeopodidae and are of course ascribed to Cuvier. In 1831 he published a Cours d'Entomologie in his own name wherein he described the Siphonostoma as an order of the section Edentata of the class Crustacea. He calls the second family of this order Lernaeiformes, but does not include in it any of the Lernaeidae, thus failing to recognize their relationship with the Siphonostomata and other crustacea.

Desmarest, in his monograph of the crustacea (1825), after showing that the Lernaeidae belong with the Caligidae among the crustacea, finally places them under the Poecilopoda, an order of the subclass Entomostraca. Wiegmann, in his Grundriss der Zoologie (1823), was the first to give the Lernaeidae their proper position, partly agreeing with Blainville, partly with Desmarest, and partly with other German investigators like Nitzoch and Leuckart. He was followed by Nordmann (1832) and Burmeister (1833), who confirmed the position assigned to the Lernaeidae, and added many of the facts necessary to confirm their views. Nordmann established the new genera *Achtheres*, *Basanistes*, and *Tracheliastes*, and described new species in several of the old genera. Burmeister at the close of his paper adds some general considerations in which he gives us the first division of the group Siphonostoma into five families. The second of these, the Lernaeoda, corresponded almost exactly with the modern family Lernaeopodidae, but included, beside the true Lernaeopod genera, *Chondracanthus* and *Lernanthropus*.

Milne Edwards was thus furnished with a large amount of necessary data which enabled him in his great work, Histoire Naturelle des Crustacés (1840), to perfect the classification of the parasitic copepods in many particulars. He recognized two orders, the Siphonostoma, including the Argulidae, the Caligidae, the Pandaridae, the Dichelestiidae, and the Ergasilidae, and for the second order the Lernaeidae, including the Chondracanthidae, the new family, the Lernaeopodidae, and the Lernaeoceridae.

The family was thus first introduced by Milne Edwards, and since that introduction the only changes in it have been the addition or removal of various genera.

Family LERNAEOPODIDAE Milne Edwards.

Family characters of female.—A fixed parasite; head usually separated from the thorax, often borne on a long neck; trunk usually unsegmented, with or without posterior processes; abdomen and anal laminae often lacking; first antennae small and with few joints; second antennae biramose, flattened laterally, not prehensile; upper and under lips prolonged into a sucking tube fringed with hairs; mandibles toothed; first maxillae rudimentary, palplike; second maxillae modified into attachment organs, usually joined at the distal end and furnished with a bulla; maxillipeds of the usual prehensile form, tipped with claws; no swimming legs; egg strings large, multiseriate.

Male.—A pigmy clinging to the body of the female but free to move about; head usually separated from the trunk, the latter more often segmented than in the female; anal laminae usually present; first maxillae similar to those of female; second maxillae and maxillipeds large and powerful, and furnished with prehensile claws; first two pairs of swimming legs sometimes present in the adult (genus *Achtheres*), but degenerate and useless.

Remarks.—The different investigators have adopted very different methods of classification in dealing with this family. Burmeister (1833) used the structure and position of the attachment organs (Haftorganen) as the basis of the first division, and the length and shape of the cephalothorax as the basis of the second division. Milne Edwards (1840) used the same basis for his first division, but for the second one he introduced the relative position of the second maxillae and maxillipeds.[1] Baird (1850) used the structure and fusion of the second maxillae for his first and only division, which is really a generic one, since he included in the family simply the two genera *Lernaeopoda* and *Anchorella*. Heller (1865) based his first division on the presence or absence of maxillipeds, his second on the structure of the second maxillae, and his third on the form of the cephalothorax. Gerstaecker (1881) used the length and thickness of the cephalothorax for his first division, the separation or fusion of the neck and body for the second division, and the structure of the attachment organs for the third division.

---

[1] He called them first and second maxillipeds.

Since Gerstaecker there has been no serious attempt at a revision of the classification of this family, though valuable suggestions have been made by Neresheimer (1909) and others.

The following scheme of classification is a combination of all these which have preceded it, with such additions as more recent investigations demand. The most important of these additions and the one thing which can give the present scheme any credit, if indeed it can claim such, is the use of the male. The males are less degenerate than the females and the only reason why they have not hitherto been employed by systematists has been the fact that so few of them have been known. Nearly every investigator has called attention to the desirability of the male as a basis of generic distinction. Some have plainly stated that the ultimate decision in every question of generic validity must rest with the male. This being appreciated even by those who lacked the facts necessary to use it, it follows that type distinctions among the males ought to possess superior value in distinguishing the genera. Accordingly, so far as has been possible in the following classification, each genus presents a certain type of male, which is fully described and figured in the genus diagnosis. To facilitate comparison these 17 male types are shown side by side in plates 25 to 28, the scale mark by the side of each representing one-tenth of a millimeter.

TABLE OF GENERA.

1. Maxillipeds inside of second maxillae and the two close behind the mouth tube; cephalothorax neither narrowed nor flattened, in line with the trunk or inclined forward..LERNAEOPODINAE, 2.

1. Maxillipeds inside of second maxillae and the two removed a considerable distance behind the mouth tube; cephalothorax much narrowed and flattened, inclined backward, or arched dorsally ..................TRACHELIASTINAE, 5.

1. Maxillipeds removed some distance behind the mouth tube, second maxillae an equal distance behind the maxillipeds; cephalothorax neither narrowed nor flattened, in line with the second maxillae and at right angles to the trunk axis..BRIANELLINAE, 6.

1. Maxillipeds close to the mouth tube, second maxillae removed a considerable distance behind them; cephalothorax narrowed and wormlike, in line with the trunk axis or inclined backward.......................CLAVELLINAE, 7.

2. Second maxillae much longer than the cephalothorax; the latter always separated from the trunk by a well-defined groove and often by a sort of neck .... 3.

2. Second maxillae stout and but little longer than the cephalothorax; the latter fused with the body, without any traces of separation or segmentation...... 4.

3. No dorsal carapace on the cephalothorax; a genital process but no anal laminae, posterior processes, or abdomen; trunk stout and unsegmented.
Salmincola, new genus, p. 603.

3. A partial dorsal carapace; no anal laminae or posterior processes, but a distinct abdomen, sometimes segmented; trunk also often partially segmented; male type *A*, pl. 25..............................*Achtheres* Nordmann, 1832, p. 617.

3. A distinct dorsal carapace; second and third thorax segments more or less differentiated; no genital process nor anal laminae; two posterior processes ventral to the egg strings; male type *B*, pl. 25....*Lernaeopoda* Blainville, 1822, p. 631.

3. A distinct dorsal carapace; trunk unsegmented; no genital process nor anal laminae; two posterior processes dorsal to the egg strings; male type *D*, pl. 25.
Lernaeopodina, new genus, p. 639.

4. Fused head and trunk covered with longitudinal rows of knobs or tubercles; male unknown..................................*Basanistes* Nordmann, 1832, p. 643.

4. Fused head and trunk smooth, without tubercles or knobs; male type *N*, pl. 28.
Vanbenedenia Malm, 1860, p. 644.

5. Cephalothorax distinctly separated from the trunk; second maxillae united at the tip and furnished with a bulla; male unknown.
Tracheliastes Nordmann, 1832, p. 644.

6. Second maxillae shorter than the cephalothorax, three-quarters fused and with branching horns instead of a bulla; mouth tube depressed; male unknown.
Brianella, new genus, p. 647.

6. Second maxillae twice as long as the cephalothorax, entirely separate and with an ordinary bulla; mouth tube projecting prominently; male unknown.
Thomsonella, new genus, p. 649.

7. Trunk, or second maxillae, or both, with deeply incised, fimbriate processes; cephalothorax in line with the trunk.......................................8.

7. No fimbriate processes on either the trunk or the second maxillae; cephalothorax inclined to the trunk...9.

8. Cephalothorax short, thickset, and straight; anterior fimbriate processes on the second maxillae; posterior ones on the posterior margin of the trunk; male type *G*, pl. 26................................*Thysanote* Krøyer, 1863, p. 650.

8. Cephalothorax long, slender, and curved; both sets of processes entirely separate from the second maxillae and the posterior margin; male type H, pl. 26.
Thysanotella, new genus, p. 651.

9. Cephalothorax short and stout, in line with the trunk, the two separated by a distinct and very narrow neck; second maxillae entirely fused, with a bulla; no genital process, anal laminae, or posterior processes; male unknown.
Cauloxenus Cope, 1872, p. 665.

9. Cephalothorax short and stout, flexed backward; second maxillae entirely separate, each ending in a clasping enlargement; no bulla, genital process, or anal laminae; two small posterior processes, dorsal; male type I, pl. 26.
Charopinus Krøyer, 1863, p. 652.

9. Cephalothorax elongate and wormlike, curved or flexed at an angle with the trunk; second maxillae in the form of broad clasping muscle bands; no bulla, genital process, or posterior processes, but an unsegmented abdomen with anal laminae; male type J, pl. 27 ....*Naobranchia* Hesse, 1863, p. 657.

9. Cephalothorax elongate and wormlike, flexed at an angle with the trunk; second maxillae normal and furnished with a bulla............................ 10.

10. Second maxillae short and completely fused, often entirely lacking; a genital process, but no abdomen or anal laminae, and usually no posterior processes. 11.

10. Second maxillae long and separate to their tips; a genital process and from two to six posterior processes, but no abdomen or anal laminae.................. 12.

11. Second antennae uniramose, turned down across the frontal margin; first maxillae bipartite; first antennae three-jointed; male type M, pl. 27.
Clavella Oken, 1815, p. 666.

11. Second antennae biramose, turned down across the frontal margin, ventral ramus two-jointed; posterior processes sometimes present; first maxillae bipartite; first antennae four-jointed; male type, K, pl. 27....*Clavellopsis*, new genus, p. 686.

11. Second antennae biramose, turned down across the frontal margin, ventral ramus unsegmented; first maxillae tripartite; first antennae three-jointed; male type L, pl. 27 .... *Clavellodes*, new genus, p. 689.
11. Second antennae biramose, projecting forward, ventral ramus unsegmented; first antennae very large, four-jointed, projecting forward and often armed with large spines; first maxillae bipartite; male type E, pl. 26. *Clavellisa*, new genus, p. 693.
12. No posterior processes; no dorsal carapace; both rami of second antennae unsegmented; male type P, pl. 28 .... *Eubrachiella*, new genus, p. 716.
12. Two or four posterior processes; a distinct dorsal carapace; exopod of second antennae two-jointed .... 13.
12. Six or eight posterior processes; no genital process; cephalothorax flexed forward, not backward .... 14.
13. Cephalothorax separated from the trunk by a distinct groove; first maxillae bipartite; second maxillae with fingerlike processes or with a club-shaped bulla; male type O, pl. 28 .... *Parabrachiella*, new genus, p. 713.
13. No groove between the cephalothorax and trunk; first maxillae tripartite; second maxillae without processes or with an ordinary button-shaped bulla; male type C, pl. 25 .... *Brachiella* Cuvier, 1830, p. 698.
14. No dorsal carapace; exopod of second antennae two-jointed; second maxillae separate to their tips; first maxillae bipartite, palp with two spines; male type F, pl. 26 .... *Epibrachiella*, new genus, p. 715.
14. A distinct dorsal carapace; both rami of second antennae unsegmented; second maxillae completely fused; first maxillae tripartite, no palp; male type R, pl. 28 .... *Probrachiella*, new genus, p. 716.

Synonyms.—The mouth parts being difficult to discern while the swimming legs are entirely lacking, the old investigators were compelled to depend largely upon the general form, the external appearance, and the egg strings. These features are changeable enough at their best, but when we reflect that practically every specimen described by those investigators had been preserved in strong alcohol we wonder that they located so many of them correctly. The alcohol warps and distorts the soft and unresisting tissues, wrinkles the skin, changes or bleaches out the color, and shrinks the bodies. In view of these facts it is not surprising that the same animal in three or four different kinds of preservation has served as the type of as many distinct species or even genera. In consequence there are very few of the genera which do not have at least one synonym, while some of them have as many as four. The following is a list of the synonyms as at present recognized:

Pediculus.—Baird in his British Entomostraca says: "the first notice taken of any species appertaining to the genus [Lernaeopoda] was by Gisler in 1751, who, in the twelfth volume of the 'Acta Suecica,' describes and figures a species of *Lernea* found by him on the salmon, and which he called '*Pediculus salmonis* or *Lax-lusen*'". There is no twelfth volume, 1751, of the Acta Suecica, but in vol. 12, 1751, of Kongl. Svenska Vetenskaps Academiens Handlingar, p. 185, Nils Gissler described "Lax-lusen," but did not mention *Pediculus*. Hence the name must be dropped, especially as it was afterwards used by Linnaeus for a genus of Epizoa.

Schisturus.—This name was applied by Rudolphi in 1809 to a genus of worms, and by Oken in 1815 to a single species of the genus *Clavella.* In this latter use it becomes a synonym.

Entomoda.—Applied by Lamarck in 1818 to the genus *Lernaeopoda;* but as the type or first species named by Lamarck under his new genus was *E. cornuta,* which belongs to the genus *Chondracanthus,* established in 1811, it is evident that the name can not be used for a Lernaeopod.

Anchorella.—Proposed by Cuvier in 1830 for a single Lernaean which he wished to establish as a new genus, and afterwards applied by other authors to the entire genus *Clavella,* excluding the latter name. But the name *Clavella* had been published by Oken in 1815 and hence *Anchorella* is either a distinct genus or becomes a synonym (see p. 667).

Lernaeomyzon.—Proposed by Blainville in 1822 for this same genus *Clavella,* but the latter had seven years' precedence.

Hessia.—In 1870 Edouard van Beneden published a paper [1] entitled "Developpement des genres *Anchorella, Lernaeopoda, Brachiella,* et *Hessia.*"

No description of this last-mentioned genus is given, nor any figures except of the eggs and one larval stage. Beneden says of it that it approaches on the one side *Anchorella,* which it resembles in all the phenomena of development, while on the other hand it is like certain of the Chondracanthidae in its external appearance; that it is a very common parasite along the coast of Brittany in the gill cavity of *Trigla lineata.* It may be the same species that Richiardi afterwards designated as *Anchorella carusi.* But he also has given us no description or figures; hence both designations become mere names until something further is known about them.

Cestopoda.—Kurz in his admirable paper on the Lernaeopodidae (1877) described and figured a new genus and species which he designated as *Cestopoda amplectens.* But 14 years before Hesse had described a new genus and species which he called *Naobranchia cygniformis.* The two genera are identical, although the species are distinct, and hence Kurz's name must become a synonym of that given by Hesse.[2]

Stylophorus.—In 1878 Hesse published the description and figures of another new genus and species which he called *Stylophorus hippocephalus.* But on examination this proves to be the same genus that Krøyer had designated as *Charopinus* in 1863. Hence Hesse's name must become a synonym of Krøyer's.

Thynnicola.—Miculicich in 1904 described what he thought to be a new genus and species under the name *Thynnicola ziegleri,* but which proved to be the same that Cuvier had named *Brachiella thynni*. The former thus becomes a synonym of the latter name.

---

[1] Bull. Acad. Roy. Belgique, ser. 2, vol. 29, p. 223.

[2] Annales des Sciences Naturelles, ser. 4, vol. 20, p. 101, pl. 1.

LERNAEOPODINAE, new subfamily.

Subfamily characters of Female.—Cephalothorax shorter than the arms, and in line with the body or bent forward at an angle; trunk plump, sometimes with, sometimes without, posterior processes, but often showing more or less distinct segmentation; a genital process in some genera but no anal laminae; second maxillae outside of maxillipeds and the two close behind the base of the mouth tube; the maxillae united only at the tips, sometimes entirely separate; bulla, when present, of the ordinary type; egg strings usually short and plump.

Male.—Cephalothorax separated by a well-marked groove from the body, which is often segmented; anal laminae present and usually directed backward; second antennae biramose and armed with a claw.

SALMINCOLA, new genus.

Generic Characters of Female.—Cephalothorax short, stout, and inclined at an angle to the body axis; separated from the trunk by a groove, but with no definite waist; no dorsal carapace; trunk short and stout, often flattened dorso-ventrally, with no signs of segmentation; no abdomen, anal laminae, or posterior processes; a small transparent genital process is present in the young female and often in the adult. First antennae indistinctly three-jointed, usually showing no segmentation; second antennae biramose, both rami one-jointed, the endopod larger than the exopod; first maxillae tipped with three spines and without a palp; second maxillae short and stout, joined at the tip by a button or mushroom-shaped bulla, often joined also at the base around the back of the thorax, forming a pair of "shoulders;" maxillipeds with a stout basal joint and a slender terminal claw; egg strings usually long and slender, eggs small and numerous.

Generic characters of male.—Size small (0.50 mm.); cephalothorax about the same length as the trunk, the two bent into the form of a semicircle; no dorsal carapace; trunk a little stouter than the cephalothorax and indistinctly segmented, with a pair of short anal laminae curved dorsally; no abdomen; first antennae three-jointed; second antennae biramose, the exopod (ventral ramus) uncinate; second maxillae and maxillipeds each three-jointed, attached to the concave margin of the semicircle at the center, their tips reaching the same level as the tips of the antennae and the anal laminae; maxillipeds stouter than the second maxillae and attached inside the bases of the latter.

Type.—*Salmincola salmonea* (*Lernaea salmonea* Gissler).

(*Salmincola, Salmo,* the host family and *incola,* a dweller.)

Remarks.—This new genus differs from *Lernaeopoda* in the absence of a dorsal carapace on the cephalothorax, in the fact that the first thorax segments are not differentiated, in the absence of posterior processes and a palp on the first maxillae, and in the presence of a genital process. From *Lernaeopodina* it may be distinguished by the absence of a dorsal carapace, posterior processes, and the palp on the first maxillae, by the presence of a genital process, and by the structure of the maxillipeds.

From *Achtheres* it may be separated by the configuration of the top of the head (see figs. 19 and 69), by the absence of a neck and abdomen, by the presence of a genital process, and by the form of the second antennae, which are folded across the front of the head in *Achtheres,* but are carried straight forward in *Salmincola.*

The only male of the genus thus far discovered is that of *edwardsii* which has recently been described and figured by Fasten.[1]

It shows a much closer relationship to *Achtheres* than to *Lernaeopoda,* but may be distinguished by its smaller size, by the curvature of the cephalothorax and trunk, and by the structure of the second antennae.

TABLE OF SPECIES.

1. Body two or three times as long as the cephalothorax and much wider, flattened dorso-ventrally and not inflated .... 2.
1. Body and cephalothorax of about the same length, trunk wider and considerably inflated, sometimes spherical; arms much shorter than the trunk and with a petioled bulla .... 7.
2. Cephalothorax as wide or wider than long and nearly in line with the trunk .... 3.
2. Cephalothorax much longer than wide and at right angles to the trunk axis .... 6.
3. Arms straight and considerably longer than the trunk .... 4.
3. Arms more or less curved and shorter than the trunk .... 5.
4. Bulla funnel-shaped; two chitinous appendages between the bases of the first maxillae .... *alpina* (Olsson), 1877.
4. Bulla mushroom-shaped; body much flattened, thinner posteriorly than anteriorly .... *californiensis* (Dana), 1852, p. 605.
4. Bulla orbicular with a long petiole; maxillipeds large and stout, without accessory spines .... *carpionis* (Krøyer), 1837, p. 606.
5. Bulla scoop-shaped, with its concave ventral surface applied to the outside of the gill filament; maxillipeds with accessory peg on ventral surface of basal joint .... *salmonea* (Gissler), 1751, p. 607.
5. Bulla pear-shaped; maxillipeds with a minute tooth on the inner margin of terminal joint .... *coregonorum* (Kessler), 1868.
6. Bulla mushroom-shaped and petioled, arms longer than the trunk; maxillipeds plainly visible, with a large papilla on the basal joint *siscowet* (Smith), 1874, p. 608.
6. Bulla mushroom-shaped and petioled; arms longer than the trunk and covered with a "vagina;" maxillipeds concealed between the arms and without papillae .... *lotae* (Olsson), 1877.

---

[1] Biol. Bull., vol. 27, p. 116, pls. 1-3.

6. Bulla globular and sessile; arms much shorter than trunk; maxillipeds plainly visible, very large, destitute of claws; trunk contracted anteriorly into a neck.. *maraenae* (Olsson), 1877.
6. Bulla spherical and sessile; arms longer than trunk; maxillipeds plainly visible, slender, bearing claws; trunk spool-shaped and much elongated. *extensa* (Kessler), 1868.
7. Dorsal outline of head elongate with concave sides; maxillipeds with accessory spines on basal or terminal joints, or both................................ 8.
7. Dorsal outline of head broadly ovate with convex sides; maxillipeds without accessory spines and often without claws................................ 10.
8. Bulla mushroom-shaped with enlarging pedicel; maxillipeds plainly visible, but only reaching the base of the mouth tube; first maxillae with palp. *edwardsii* (Olsson), 1869, p. 609.
8. Bulla conical with enlarging pedicel; maxillipeds visible and reaching anterior margin of head; first maxillae without a palp and with 2 setae. *oquassa*, new species, p. 611.
8. First maxillae without a palp but with 3 terminal setae; maxillipeds of varying lengths.. 9.
9. Bulla mushroom-shaped with two distinct pedicels; maxillipeds wholly visible, with a large spine on the basal joint; egg tubes widely separated at their base, *bicauliculata* (Wilson), 1908, p. 612.
9. Bulla mushroom-shaped, only one pedicel; maxillipeds partly hidden; no spine on basal joint; egg tubes close together at their base. *falculata* (Wilson), 1908, p. 613.
9. Bulla club-shaped, five times as long as wide; maxillipeds completely hidden between the arms; the latter short and much swollen. *thymalli* (Kessler), 1868, p. 613.
10. No terminal claws on maxillipeds; egg tubes turned forward and curled against the trunk; diameter of bulla much greater than that of the arms............ 11.
10. Small terminal claws present on maxillipeds; egg tubes long and slender and in normal position; diameter of bulla about the same as that of the arms........ 12.
11. First antennae two-jointed; exopod of second pair a segmented papilla; first maxillae short and stout; toothed edge of mandible continuous and uninterrupted. *inermis* (Wilson), 1911, p. 614.
11. First antennae unsegmented; exopod of second pair a claw; first maxillae long and slender; toothed edge of mandible with a wide gap near the center. *extumescens* (Gadd), 1901.
12. Cephalothorax in line with trunk; basal joint of maxilliped very slender; exopod of second antenna distinctly jointed; no accessory spine on maxillipeds. *arcturi* (Miers), 1877.
12. Cephalothorax at an obtuse angle with trunk; basal joint of maxillipeds stout and armed with accessory spine; exopod of second antenna not jointed. *beani* (Wilson), 1908, p. 615.
12. Cephalothorax at right angles to trunk; bases of arms forming a pronounced hump across back of head; terminal claw of maxillipeds large. *gibber* (Wilson), 1908, p. 615.
12. Cephalothorax at right angles to trunk; no pronounced hump; no claw on maxillipeds.................................. *carpenteri* (Packard), 1874, p. 616.

SALMINCOLA CALIFORNIENSIS (Dana).

Lernaeopoda californiensis DANA, 1852, p. 1379, pl. 96, figs. 1*a* and 1*b*.

Plate 29, figs. 16 and 17.

Host and record of specimens.—Several females were taken from the body of a salmon (*Oncorhynchus*) in the Klamath River, California, by the Wilkes Exploring Expedition. Four females were collected by Dr. B. W. Evermann from the gills of *Oncorhynchus nerka* at the inlet of Big Payette Lake, Idaho, September 27, 1894. These were identified by G. G. Gurley, and from them he obtained the measurements given below. Unfortunately none of these specimens appear in the United States National Museum collection.[1]

Specific characters of female.—Cephalothorax in line with the trunk axis, triangular in outline, one-third the length of the trunk, nearly twice as wide as long, with rounded corners. Trunk elliptical, at the center nearly twice as broad as the head, drawn to a rounded point posteriorly between the egg strings. In lateral view both the head and the trunk are flattened into a continuous straight line on the ventral surface, but very convex dorsally. The trunk is thickest anteriorly and the cephalothorax posteriorly, and each tapers rapidly toward the opposite extremity. Egg strings slender, cylindrical, and one-half longer than the trunk; eggs in 8 or 10 longitudinal rows, about 30 in a row. Second maxillae short and stout and much wrinkled, joined to the bulla by a long and slender pedicel; bulla mushroom-shaped, its diameter considerably greater than that of the maxillae themselves; maxillipeds short and slender.

Male.—Unknown.

Color (preserved material), a uniform grayish white. Total length, 3.5 mm.; breadth, 2.8 mm.; length of arms, 2.72 mm.; length of bulla pedicel, 0.95 mm.; length of egg strings, 4.36 mm.

(*californiensis*, from the locality in which it was found).

Remarks.—In support of his identification Gurley notes the fact that *Oncorhynchus nerka*, from which Doctor Evermann obtained his specimens, is the species which occurs in the Klamath River, where Dana's types were found. The species seems to be a valid one, although there are no specimens of it now available. For this reason and because Dana's figures are not readily accessible they are reproduced here (pl. 29, figs. 16 and 17) somewhat enlarged, but otherwise just as he published them.

SALMINCOLA CARPIONIS (Krøyer).

Lernaeopoda carpionis Krøyer, 1837, p. 268, pl. 2, fig. 6.

Remarks.—Krøyer distinguished this species from *salmonea* as follows, a distinction which Bassett-Smith and others have tried to set aside.

> *Salmonea*, head small, less than a fourth the length of the animal, subtriangular, of the same length and width, directed straight forward or a little backward. Arms elongate, equaling or exceeding the length of the trunk and making an obtuse angle with it; bulla recumbent, depressed, oval, yellow, subcartilaginous, and without a pedicel. External egg sacks short, slender, almost filiform, with two transverse series of eggs at the most.

---

[1] Eight females have since been taken from the same host and locality; they have received Cat. No. 43563, U.S.N.M., and will be more fully described later.

Carpionis, head large, more than a fourth the length of the animal, ovate, much longer than wide, making with the trunk a right angle or one a little acute. Arms shorter than the trunk, often pressed against the surface of the underlying segment; bulla large, orbicular, very convex, black, horny, with an elongate and slender pedicel. External egg sacks of medium size with three or four transverse rows of eggs.

In Krøyer's figures there are also decided differences in the structure of the maxillipeds and second antennae, which make his specific distinction a valid one, and accordingly the two species have both been placed in the new genus *Salmincola.*

SALMINCOLA SALMONEA (Gissler).

Plate 29, figs. 18 to 22.

Lax-lusen, Lernaea salmonea Gissler,[1] 1751, p. 185, pl. 6, figs. 1–5.
Lernaea salmonea Linnaeus, 1761, p. 509, No. 2102.
Schisturus salmoneus Oken, 1816, p. 183.
Entomoda salmonea Lamarck, 1818, p. 686.
Lernaeopoda salmonea Blainville, 1822, p. 443.

Host and record of specimens.—Three females with egg strings from the gills of a salmon at Bamffshire, England, were obtained by exchange from Canon A. M. Norman, and are numbered 8339, U.S.N.M.

A second lot of six females was obtained by R. Hitchcock from the gills of salmon in England and is numbered 39608, U.S.N.M.

Specific characters of female.—Cephalothorax short and stocky, three-lobed in dorsal view, being enlarged posteriorly through the bases of the second maxillae; separated from the trunk by a distinct groove; no dorsal carapace. Trunk a flattened ovoid or pyriform, narrowed anteriorly into a short neck, considerably enlarged and often somewhat three-lobed posteriorly, with a minute genital process at the center of the median lobe; no abdomen, anal laminae, or posterior processes.

First antennae short and tipped with a minute spine; no external indication of segmentation. Second antennae biramose; exopod longer and larger than the endopod and tipped with a large curved spine and two or three smaller ones; both rami one-jointed.

First maxillae slender and tipped with three small jointed setae, no palp; second maxillae, including the bulla, the same length as, or slightly shorter than, the entire body, joined at the tip to a large ovate bulla, sometimes by a single pedicel, sometimes by two distinct pedicels. Bulla as wide as both maxillae together, concave ventrally, convex dorsally, thickened and projecting back of the pedicel along the proximal margin. This bulla is turned down so that its long axis is parallel with that of the maxillae and its concave ventral surface is applied to the outside of the gill filament, instead of being buried in its tissue.

Maxillipeds with a stout basal joint and a short, slender, curved claw; the latter with an accessory spine near the center of its inner margin; the former with a short and stout spine or peg on its ventral surface near the base of the terminal claw. This spine is not in line with the terminal claw but the latter shuts past it dorsally.

---

[1] Kongl. Svenska Vetenskaps Academiens Handlingar, vol. 12.

Male.—Unknown. Color a uniform yellowish-white; bulla bluish or light purple. Total length (without egg strings) 7 to 8 mm.; breadth, 3 mm.; length of arms, 5 mm.; of bulla, 1.5 mm.; of egg strings, 6 mm.

(*salmonea*, of or pertaining to salmon).

Remarks.—This species has been described by so many authors that very little is left to be added. Attention, however, is called to the fact that the median projection at the posterior end of the body is not an abdomen but a genital process like that in *Clavella*. Also the "two apical knobs" mentioned by some authors are really spermatophores (see fig. 22). The bulla is very peculiar in its application to the gill filament, as well as in its shape and orientation. The peculiar pattern of the dorsal surface of the head is a good characteristic of the species, and this with the bulla affords a ready means of identification. These points, together with the peg on the maxillipeds, are the chief reasons for presenting the figures here given.

SALMINCOLA SISCOWET (Smith).

Plate 30, figs. 23 to 29.

Lernaeopoda siscowet Smith, 1874, p. 664, pl. 3, figs. 15–16.

Host and record of specimens.—Seven adult females with egg strings were taken from the gills of *Cristivomer namaycush siscowet* at Outer Island, Lake Superior, by J. W. Milner. They are numbered 39597, U.S.N.M. and are labeled in Professor Smith's handwriting "*Lernaeopoda siscowet* Smith, Cotypes."

Specific characters of female.—Cephalothorax ovate, flattened dorsoventrally, coming to a rather sharp point anteriorly, and thickened posteriorly through the bases of the arms so that it overhangs considerably the trunk, from which it is separated by a very distinct groove. Dorsally the cephalothorax is strongly arched, while ventrally the large maxillipeds stand out prominently, like an under jaw. Trunk pear-shaped, considerably narrowed anteriorly, but not forming a distinct neck; only a little longer than wide, with obscure segmentation grooves on the ventral surface; strongly arched dorsally and truncated posteriorly, but ventrally extending a little back of the bases of the egg strings.

The latter are cylindrical and as long as the entire body or longer; eggs in 6 or 7 longitudinal rows, much twisted, about 30 eggs in each row.

First antennae of medium length and tipped with 2 or 3 minute spines, but very obscurely segmented; second pair biramose, the exopod one-jointed, longer than the endopod, enlarged a little at the tip and armed with a few straggling spines; the endopod two-jointed, the basal joint swollen into a large ventral knob armed with spines and similar to the one in *Salmincola edwardsii* (p. 610); the terminal joint narrow and palplike and tipped with a single fleshy point on the margin next to the exopod. There is also a knob on the outer surface of the basal joint, close to the base of the endopod which projects strongly and is armed with curved spines. Mandible stout, broadened toward the base and curved, armed with four large distal teeth, which are curved and bluntly pointed, and one small, sharp proximal tooth. First maxillae short and slender, tipped with two conical spines and without a palp; second maxillae as long as, or even considerably longer than, the trunk, slender, nearly straight, and a trifle enlarged at the tips. Bulla mushroom-shaped, its diameter almost three times that of either arm, its pedicel long, large, and inflated at the distal end. Maxillipeds of medium size, the terminal joint curved and tipped with a short curved claw and an inner minute spine; the basal joint with a large papilla on its ventral surface, which is terminated by two small papillae, each bearing a spine which seems to be retractile.

Color (preserved material) a uniform yellowish-white.

Total length (excluding egg strings), 7 mm. Length of cephalothorax, 2.8 mm.; of trunk, 4.2 mm.; of second maxillae (including bulla), 8 mm.; of egg strings, 7 mm. Width of trunk, 2.8 mm.

(*siscowet*, Indian name of host).

Male.—Unknown.

Remarks.—This species was described and figured by Smith in 1874 and has not since been seen by any investigator. Fortunately, some of Smith's original specimens have been preserved in the United States National Museum, and from them the present description and figures have been taken. There is practically little to add to Smith's excellent description, but the second antennae and first maxillae are here figured, both of which present specific characters. These, with the peculiar outline of the top of the head, and the equally peculiar papilla on the maxillipeds, distinguish this species from all others.

SALMINCOLA EDWARDSII (Olsson).

Plate 30, figs. 30 to 35.

Lernaeopoda salmonea Mayor, 1824, p. 24.
Basanistes salmonea Milne Edwards, 1840, p. 509, pl. 41, fig. 3.
Lernaeopoda edwardsii Olsson, 1869, p. 36.—Wright, 1882, p. 246, pl. 1, figs. 1–11.
Lernaeopoda fontinalis Smith, 1874, p. 663, pl. 3, figs. 12–14.

Host and record of specimens.—Twenty-five adult females were obtained from the gills of brook trout, *Salvelinus fontinalis*, at the State hatchery at Wild Rose, Wisconsin, and have received the number 43574, U.S.N.M. A second lot of ten females were taken from the gills of the same host at Caledonia, New York, and are numbered 39587, U.S.N.M. Three females were taken from brook trout at Sleepy Creek, Houghton, Michigan, Aug. 30, 1905, by T. T. Hankinary, and are numbered 43577, U.S.N.M. There are two females probably belonging to this species, which are labeled "Lake Superior. U. S. Lake Survey. S. I. Smith, 1871," but the specimens are so shriveled in the alcohol as to make the identification uncertain.

Smith also described as a new species (*Lernaeopoda fontinalis*) specimens found upon brook trout at Norway, Maine, in A. B. Crockett's hatchery, which are undoubtedly the same as the present species.

Gurley in his manuscript reports a number of specimens from brook trout in the ponds of the U. S. Fish Commission Station, Northville, Michigan, which he collected April 26, 1894, during a severe epidemic which killed many of the fish. Specimens were also sent to the United States National Museum May 16, 1911, from trout in a small brook at South St. Paul, Minnesota, by Marshall E. Humphrey, of the Kinnickinic Fisherman's Association. These were identified by the present author and returned to Mr. Humphrey.

Specific characters of female.—Cephalothorax inclined at an angle of about 45° to the trunk axis, elongate-triangulate, broadest across the posterior margin, narrowing to a rounded point anteriorly, two-thirds as long as the trunk, and separated from it by a well-defined groove and by the ridge formed by the bases of the second maxillae. Trunk pear-shaped, narrowed anteriorly where it joins the cephalothorax, but without a definite neck; flattened on the ventral surface, strongly convex dorsally; no anal laminae or posterior processes, but in all the younger and in some of the adult specimens there is a small genital process. Egg strings short and stout, rarely longer than the trunk; eggs of good size, arranged in 4 or 5 longitudinal rows, from 12 to 15 eggs in each row. First antennae short, nearly the same diameter throughout, tipped with two or three minute spines and showing no traces of segmentation. Second antennae biramose, the exopod rounded and unsegmented, covered on the outer, and a part of the terminal, margin with short spines curved inward; the endopod two-jointed, the basal joint swollen on its ventral and lateral margins into a rounded knob covered with short curved spines, the terminal joint much narrower than the basal, palp-like, and terminating in two fleshy points. Mandibles relatively short and stout, the distal third armed with 5 or 6 curved teeth without any secondary teeth. First maxillae short and rather stout, terminating in one (Wright) or two curved spines, the palp flask-shaped, shorter than the maxilla, and terminating in one or two (Wright) curved spines. Second maxillae (excluding the bulla) about the same length as the fused trunk, the same diameter throughout, and extending around the back of the head to form a thick collar or ridge. Bulla mushroom-shaped, one-third as long and nearly twice the diameter of the maxillae, with a conical pedicel. None of these specimens showed the bilateral character spoken of by Wright (1882, p. 248). Maxillipeds three-jointed, the two basal joints considerably swollen, the terminal joints tapering strongly, the claw minute and curved.

Color (preserved material) a uniform grayish-white.

Total length (without egg strings), 4.35 mm. Length of trunk, 2.5 mm.; of arms and bulla, 2.85 mm.; of egg strings, 2.5 to 4.5 mm.

(*edwardsii*, to Milne Edwards).

Specific characters of male.—Since this is the only male known in the genus the specific characters are the same as the generic (p. 603).

Remarks.—This species was first described by Mayor in 1824 under the name *Lernaeopoda salmonea*, because he believed it to be the same as the species which Gissler, Linnaeus, and Blainville had published under that name. Milne Edwards in 1840 assigned Mayor's species to the genus *Basanistes*, while he retained Gissler's species in the genus *Lernaeopoda*. In 1869 Olsson changed the species back again to the genus *Lernaeopoda*, but confirmed Milne Edwards's opinion that it was not the same as the *salmonea* of Linnaeus. Accordingly, he proposed the new name *edwardsii* for it, and it has been thus known ever since. From the descriptions and figures of these various authors there seems to be no reasonable doubt that the form found in Europe is identical with that on the American trout. Attention is called especially to the form of the bulla, the hump joining the bases of the arms, the second antennae, and the maxillipeds as the distinguishing characters of the species.

SALMINCOLA OQUASSA, new species.

Plate 31, figs. 36 to 40.

Host and record of specimens.—Five females with egg strings were obtained from blue-back trout, *Salvelinus oquassa*, at Rangeley Lakes, Maine, Nov. 27, 1884, by Prof. L. A. Lee, of Bowdoin College. They are numbered 39604, U.S.N.M. One of them has been selected to serve as the type of the new species and is numbered 43578, U.S.N.M. They were attached to the inside of the operculum of the trout.

Specific characters of female.—Cephalothorax narrow and much longer than wide, forming with the trunk a crescent or semicircle.

Trunk pear-shaped, strongly narrowed anteriorly but without a definite neck; squarely truncated posteriorly. Egg strings considerably shorter than the trunk and rather plump, slightly curved and attached to the body not by their ends but on one side near the end, so that they project both forward and backward eggs large, arranged in 5 rows, about 10 in each row.

First antenae minute, only two joints visible, the terminal one armed with a single small spine. Second pair large and stout, the basal portion definitely two-jointed; the endopod well rounded, one-jointed and armed with numerous short and sharp spines; the exopod two-jointed and tipped with two larger and blunter spines. First maxillae quite small, set well up on the mouth-tube, and tipped with two short and stout spines. Second maxillae stout, quite straight, and joined at the tip to a conical bulla whose length and diameter are about equal to that of the arms themselves. Maxillipeds reaching the extreme tip of the mouth-tube, rather slender, ending in a curved claw with a tiny spine at its base; the second joint also carries on its ventral surface a short process armed with a blunt spine.

Male.—Unknown.

Color (preserved material) a uniform brownish-white.

Total length (without egg strings), 4.25 mm. Length of trunk, 2.5 mm; of arms, 3 mm.; of egg strings, 2 mm. Width of trunk, 1.75 mm.; of egg strings, 0.66 mm.

(*oquassa,* the specific name of the host.)

Remarks.—The above specimens were found in a collection sent to the Museum by Professor Lee. They are somewhat shrunken, but show unmistakably that they do not belong to any known species and accordingly are used as the types of a new species.

They are most closely related to *alpina* and *edwardsii,* from which they can readily be distinguished by the much greater length of the maxillipeds and by the details of the second antennae.

SALMINCOLA BICAULICULATA (Wilson).

Plate 31, figs. 41 and 42.

Lernaeopoda bicauliculata Wilson, 1908, p. 472, pl. 82.

Host and record of specimens.—Three females were taken from the tips of the gill filaments of the Dolly Varden trout, *Salvelinus malma,* at Bering Island by Gov. N. Grebnitzky. These were made the types of the species and were numbered 38594, U.S.N.M.

Two females were obtained by Dr. L. Stejneger at Bering Island in 1882, from an unknown host. These are Cat. No. 8453, U.S.N.M. A single female was taken from a "trout" at Mapleton, Oregon, by Dr. S. E. Meek in 1896, and is Cat. No. 38575, U.S.N.M.

Remarks.—This species was fully described and figured in 1908. It may be recognized by the two pedicels of the bulla, by the wide separation of the bases of the egg strings, by the peculiar pattern of the dorsal surface of the head, and by its attachment to the tips of the gill filaments. Two figures, one of them new, are introduced here for comparison.

SALMINCOLA FALCULATA (Wilson).

Plate 31, figs. 43 and 44.

Lernaeopoda falculata Wilson, 1908, p. 473, pl. 83.

Host and record of specimens.—Four females from the gills of the blue-back salmon, *Onchorhynchus nerka,* at Baker Lake, Washington, in 1902, by the United States Bureau of Fisheries, Cat. No. 38586, U.S.N.M. One female from Bristol Bay, Alaska, no date or host, Cat. No. 8340, U.S.N.M. Three lots obtained by the United States Bureau of Fisheries from trout in California, Cat. Nos. 38588, 38589, and 38590, U.S.N.M.

Remarks.—This species may be recognized by the abruptly narrowed ends of the second maxillae, by the position and length of the egg strings, and by the contour of the dorsal surface of the head. The species was fully described and figured in 1908, but two figures, one of them new, are here introduced for comparison.

SALMINCOLA THYMALLI (Kessler).

Plate 32, figs. 45 and 46.

Lernaeopoda thymalli Kessler, 1868, p. 97, pl. 4, fig. 3 *a* and *b*.—Gadd, 1904, p. 34.
Lernaeopoda clavigera Olsson, 1872, p. 63, pl. 5, figs. 1-6.

Host and record of specimens.—A single female with egg strings from the gills of *Thymallus vulgaris* at Yamtl, Sweden; three females without egg strings from *Salmo alpinus* at the same locality. Both lots were obtained by exchange with the University of Stockholm; the former is Cat. No. 20001, and the latter 19999, U.S.N.M.

Specific characters of female.—Cephalothorax egg or pear-shaped, almost twice as long as wide, two-fifths as long as the trunk, and bent at right angles to the axis of the latter, from which it is separated by a deep groove and by the thickened bases of the second maxillae. Trunk considerably thicker than the cephalothorax, somewhat flattened dorso-ventrally, with no traces of segmentation. A short conical genital process on the posterior end of the trunk, a little nearer the ventral surface; no abdomen, anal laminae, or posterior processes. Egg strings cylindrical, two-fifths as wide as, and a little longer than, the trunk; eggs small, arranged in 8 or 10 longitudinal rows, about 20 eggs in each row.

First antennae indistinctly four-jointed; second pair biramose, the endopod narrower and longer than the exopod and two-jointed, both rami covered with small spines. First maxillae small and tipped with three setae; second maxillae stout, curved forwards and inwards, their base at right angles to the body axis, and their tips considerably enlarged. Bulla as long as the second maxillae, club-shaped, sometimes lanceolate, and three or four times as long as wide. It is always buried in the tip of the gill filament and shows in its center an elongate transparent area. Maxillipeds concealed between the second maxillae, short and stout, with a curved terminal claw, having near its base several small spines.

Color (preserved material) a uniform grayish-yellow, the contents of the digestive tube a shining black.

Total length (without egg strings), 4 mm. Length of second maxillae, 1.6 mm.; of trunk, 2.8 mm.; of bulla, 1.5 mm. Thickness of trunk, 1.75 mm.

(*thymalli*, the generic name of the most common host.)

Male.—Unknown.

Remarks.—This species was first described by Kessler in 1868. Olsson in 1872, not knowing of Kessler's description, called it *Lernaeopoda clavigera*. Gadd in 1904, recognizing the identity of the two species, adopted Kessler's name and made Olsson's a synonym. It may be readily distinguished from all other species by its enormous club-shaped bulla. The three females taken from *Salmo alpinus* were labelled by the University of Stockholm "*Lernaeopoda alpina,*" but they show none of the characters of that species while they do conform in every particular to the present species. The short and very plump body and the contour of the dorsal surface of the head are also distinguishing characters.

SALMINCOLA INERMIS (Wilson).

Plate 32, figs. 47 to 51.

Lernaeopoda inermis WILSON, 1911, p. 632, pl. 68, figs. 33–36.

Host and record of specimens.—Found abundantly on the Lake herring, *Argyrosomus artedi*, in Lake Huron and Lake Superior.

The United States National Museum contains five lots of specimens: a single type female, Cat. No. 42283, U.S.N.M., from Knife River, Duluth, Minnesota; a paratype female, Cat. No. 42284, U.S.N.M., from Blind River, Lake Huron; a paratype female, Cat. No. 42285, U.S.N.M., from Marquette, Lake Superior; 140 females, Cat. No. 42278, U.S.N.M., from Saginaw Bay, Lake Huron; a single female, Cat. No. 6113, U S.N.M., from the gills of the humpback whitefish, *Coregonus nelsonii*, taken in the Yukon River, Alaska, by E. W. Nelson.

Remarks.—When this species was first described in 1911 it was placed with its nearest relatives in the genus *Lernaeopoda*.

Now that these relatives are to constitute a separate genus this species must be kept with them. It has already been fully described and figured, but attention may be called to one or two characters which appear in the large lot from Lake Huron, obtained after the previous description had been published.

The second maxillae are usually turned back against the ventral surface of the trunk, bringing the bulla close to the posterior end of the body. Young females and adults, whose ovaries are full of eggs, have a plump trunk, which is not very strongly curved and whose surface is smooth. But adults in which the eggs have been extruded into the egg strings, have a strongly curved body, with deep grooves or wrinkles. Indeed in many of these adults the cephalothorax is folded forward against the ventral surface of the trunk, the two almost touching. In these individuals there is a large longitudinal groove on either side of the body above the oviducts, and several transverse grooves, which indicate the body segmentation. The "shoulders" also project strongly in most of the specimens, making a ridge across the back of the neck. The comparative shape of the dorsal surface of the head is shown in figure 48, while the first and second antennae and the first maxillae are also presented for comparison. The species may be most readily recognized by the comparatively enormous size of the bulla, by the absence of claws on the maxillipeds, and by the turning forward of the egg strings against the walls of the trunk. From Gadd's species *extumescens*, which it most resembles, it may be told by the greater diameter of the bulla, by the larger size and prominence of the maxillipeds, by the details of the second antennae and first maxillae, and especially by the curvature of the mandibles in *extumescens*, and the wide gap in their dentition.

SALMINCOLA BEANI (Wilson).

Plate 32, figs. 52 and 53.

Lernaeopoda beani WILSON, 1908, p. 470, pl. 81.

Host and record of specimens.—Twenty-five females from the gills of the Quinnat salmon, *Oncorhynchus tschawytscha*, McCloud River, California, Cat. No. 29068, U.S.N.M., types of the species.

Two lots obtained by the United States Bureau of Fisheries at Battle Creek, Colorado, from the same host, Cat. Nos. 38584 and 38585, U.S.N.M.

One lot obtained by Dr. C. H. Gilbert from the rainbow trout, *Salmo iridens*, at Sisson, California, Cat. No. 38605, U.S.N.M.

Remarks.—This species may be distinguished by the comparative length of the second maxillae, by the size and shape of the bulla, and by the distance between the maxillipeds and the other mouthparts. The contour of the dorsal surface of the head and a side view of the body are here introduced for comparison.

SALMINCOLA GIBBER (Wilson).

Plate 33, figs. 61 and 62.

Lernaeopoda gibber WILSON, 1908, p. 469, pl. 80.

Host and record of specimens.—Fifty females from the gill arches of the Dolly Varden trout, *Salvelinus malma*, at Attu, Alaska, June

9, 1906, by the Bureau of Fisheries steamer *Albatross;* Cat. No. 38583, U.S.N.M.

Remarks.—This species is the most decidedly humpbacked in the genus, and may usually be recognized by this feature. The strong mushroom shape of the bulla and the details of the second antennae are also characteristic.

SALMINCOLA CARPENTERI (Packard).

Plate 33, figs. 54 to 60.

Achtheres carpenteri PACKARD, 1874, p. 612, fig. 1; 1875, p. 587, fig. 237.

Host and record of specimens.—A number of females with egg strings were taken from "trout" in a tributary of the East River, Colorado, by Lieut. W. L. Carpenter, August 29, 1873. Unfortunately none of these original specimens have been preserved.

Two adult females, one with egg strings, and a young female were taken from a "salmon" 42 inches long at Battle Creek, Colorado, by Dr. Edwin Linton. They have received Cat. No. 43569, U.S.N.M., and will serve as surrogate types of the species.

Specific characters of female.—Cephalothorax about as long as the trunk and turned at right angles to the latter; antennal region separated as a rounded lobe, narrowed basally and widened distally. Trunk a plump ovoid, one-half longer than wide, and so squarely truncated posteriorly that the female without egg strings may be easily balanced in an erect position. On the ventral surface are faint indications of segmentation; no abdomen, anal laminae, or posterior processes, but a well-defined genital process on the young female, with the remains of spermatophores still clinging to it. In this young female the trunk was slender, cylindrical, well rounded posteriorly, and three times as long as wide. First antennae short and unsegmented; second pair biramose, the endopod and exopod about the same length, the former tipped with four minute spines, the latter with two very much stouter conical ones. Mandibles slender and curved, armed with six teeth, the four terminal ones much larger than the two basal ones, and curved. First maxillae slender, unsegmented, without a palp, and tipped with a single seta. Second maxillae large and stout and as long as the entire body; bulla of the usual mushroom shape, with a long and slender petiole.

The second maxillae are much shorter in the young female, and each is enlarged at the tips and joined to the bulla by a distinct petiole. The bases of these arms form a well-defined ridge around the back of the head, even in the young female; maxillipeds with a stout basal joint and a short, curved terminal claw.

Color (preserved material), a uniform pale white.

Total length (without egg strings), 4 mm. Length of trunk, 2 mm.; of egg strings, 3 mm. Width of trunk, 1.75 mm.; of egg strings, 0.9 mm.

(*carpenteri*, to Lieut. W. L. Carpenter.)

Male.—Unknown.

Remarks.—Gurley in his manuscript identifies the host of Packard's specimens as *Salmo mykiss.* However that may be, it is very possible that the two lots came from the same host, since the large fish in Colorado are called indifferently trout or salmon. Packard's description and figure leave no doubt of the identity of his species with the specimens collected by Doctor Linton.

Packard recognized that it was not a true *Achtheres*, for he says: "This species should perhaps be regarded as the type of a subgenus of *Achtheres*, which it resembles more nearly than *Lernaeocera.* The abdominal segments are very faintly indicated, and in the form and degree of development of the head and appendages it seems intermediate between *Achtheres* and *Cauloxenus.*"

The additional details here presented show clearly that it belongs to *Salmincola.*

Genus ACHTHERES Nordmann.

Generic characters of female.—Body divided into three regions: a small cephalothorax with the antennal area differentiated dorsally; a plump thorax, more or less distinctly segmented, at least on the ventral surface, narrowed into a well-defined neck anteriorly, where often one of the segments is clearly separated; and a conical abdomen, usually unsegmented, but sometimes (*micropteri*) segmented; no posterior processes, anal laminae, or genital process.

First antennae distinctly three-jointed and tipped with three setae; second antennae biramose, turned down across the frontal margin, the endopod one-jointed, the exopod two-jointed; first maxillae with two terminal setae and without a palp; maxillipeds between the bases of the second maxillae, which are separate to the very tip, where they are joined to an ordinary bulla; egg strings short and stout, eggs large.

Generic characters of male.—Size medium (1 mm.); cephalothorax in line with the body axis, much smaller than the trunk and separated from it by a distinct groove; trunk spindle-shaped, clearly segmented, without an abdomen or anal laminae. First antennae three-jointed; second antennae biramose, the exopod two-jointed and tipped with a claw; first maxillae with two terminal setae and without a palp; second maxillae much longer than the maxillipeds, the two projecting strongly from the cephalothorax some distance behind the other mouth parts.

Type—Achtheres percarum Nordmann.

(*Achtheres*, ἀχθηρής burdensome, annoying).

Remarks.—This genus, as here constituted, includes only species which are parasitic upon fresh-water fishes. Of the eight species six are North American, and one of them, *coregoni*, is also found in Switzerland. The genus, therefore, may fairly be called an American one, and because the accounts of the American species are widely scattered, and in some instances difficult of access, it has been thought best to include here all that is known of them, together with some new figures which admit of easy comparison.

Synonyms.—Achtheres carpenteri Packard, 1874, p. 612, fig. 1, text, according to the characters here established can not belong to this genus at all, and is accordingly transferred to the new genus *Salmincola* (see p. 616).

Achtheres selachiorum Kurz, 1877, p. 385, pl. 25, fig. 1; pl. 27, figs. 38 to 40, is the only species found in salt water, and was stated by Claus to be the undeveloped young of *Lernaeopoda galei.*

Toward the close of his description of this "new species" Kurz stated that *Lernaeopoda galei* had been found upon the same host and in the same place. But, he added, "The identity of the two species does not appear possible. The great differences in form in *L. galei,* as van Beneden himself shows, may possibly be an indication of a difference in species (p. 388). That which induces me to cling to this new species is the elongate body form, the longer and narrower egg sacks, the club-shaped anal laminae, the distinct segmentation of the body, and the three-parted form of the attachment button in *L. galei,* not to mention other minor differences in the structure of the mouth parts" (p. 389).

All the differences enumerated by Kurz admit of easy explanation provided the specimens he secured were undeveloped young of *L. galei,* and this would be further indicated by the size he has given for them. On the other hand, to try and make of them a new species of *Achtheres* is impossible, because they are so large for that genus that they must be mature adults, but they possess a pair of good-sized posterior processes, they have no abdomen comparable with that in *Achtheres,* while the first maxillae are tripartite and have a palp. We are hence forced to accept Claus's statement that this species is a synonym of *L. galei.* The "*Achtheres* sp." mentioned by Wright (1892, p. 438, fig. 10, text) is probably the same as Krøyer's *A. pimelodi* (see p. 628).

TABLE OF SPECIES.

1. Cephalothorax about as wide and as long as the trunk; bulla an enormous disk (3 mm. in diameter); maxillipeds reaching the frontal margin of head. *corpulentus* Kellicott, 1880, p. 619.

1. Trunk once and a half to twice the length and width of the cephalothorax; bulla and maxillipeds normal size.......... 2.

2. Abdomen much narrower than, and joined abruptly to, the trunk, inclined anteriorly and more or less distinctly segmented.......... 3.

2. Abdomen the same width as the posterior portion of the trunk and passing imperceptibly into it; in the same line as the trunk axis, and with no traces of segmentation.......... 4.

3. Arms stout; carapace much widened anteriorly; second antennae almost touching across the frontal margin; first antennae distinctly jointed. *micropteri* Wright, 1882, p. 620.

3. Arms slender; carapace scarcely widened anteriorly; a wide gap between the tips of the second antennae; first antennae with no traces of segmentation. *lacae* Krøyer, 1863, p. 622.
4. Genital segment with a jointed process on either side, on the ventral surface at the posterior margin..*sandrae* Gadd, 1901.
4. No jointed processes; abdomen transversely lunate or hemispherical; maxillipeds projecting beyond anterior margin and not concealed by second maxillae. *coregoni* (Smith), 1874, p. 623.
4. No jointed processes; abdomen conical and pointed; maxillipeds small and their bases completely hidden between the second maxillae...................... 5.
5. Carapace ovate, much narrowed and well rounded posteriorly; mouth-tube projecting considerably........................*amblopltis* Kellicott, 1880, p. 626.
5. Carapace trapezoidal, twice as long as wide, almost covering the second antennae; mouth-tube not visible dorsally..................*pimelodi* Krøyer, 1863, p. 628.
5. Carapace trapezoidal, about the same length and width; not covering the second antennae; mouth-tube not visible dorsally....*percarum* Nordmann, 1832, p. 629.

ACHTHERES CORPULENTUS Kellicott.

Plate 34, fig. 63.

Achtheres corpulentus Kellicott, 1880, p. 54, pl. 1, figs. 1 to 3.

Host and record of specimens.—Kellicott's specimens were taken from the gills and gill cavity of the lake herring, *Leucichthys artedi*, in Buffalo Harbor and Niagara River. The species has also been obtained as follows: In the gill cavity of the bloater whitefish, *Leucichthys prognathus*, from Lake Ontario, at Wilson, New York, by R. R. Wright. On the gills of lake herring from Lake Erie, at Dunkirk, New York, July 7, 1894, collected and identified by Cloud Rutter. On gills of lake herring from Lake Michigan, off Milwaukee, and on gills of ki-eye, *Leucichthys hoyi*, at the same locality, collected by C. H. Stevenson and identified by G. G. Gurley. From gills of bloater whitefish, Whitefish Bay, Lake Michigan, July, 1894, by R. Rathbun. From bloater whitefish, Lake Ontario, at Wilson, New York, August 26, 1894, by G. G. Gurley. From gills of whitefish, *Coregonus clupeiformis*, Lake Erie, at Dunkirk, New York, July 8, 1894, collected by Cloud Rutter and identified by G. G. Gurley.

Specific characters of female.—Head nearly as long and as wide as the body, ovate, with the anterior end very pointed and the posterior end broadly rounded; body in dorsal view broadly elliptical, nearly as wide as long, in lateral view hemispherical, with the tip drawn well under, as in the abdomen of certain female spiders. First antennae apparently two-jointed, the terminal joint short and tipped with four tiny setae; second antennae stout and fleshy, reaching to the anterior margin of the head; mandible with seven teeth, the second tooth the longest, the succeeding ones diminishing regularly in size; second maxillae longer than the body, tapering considerably and much wrinkled; bulla a broad and flat disk. Egg sacks broad at the base, tapering toward the apex, a little longer than the body and turned upwards and backwards against the dorsal surface of the trunk; eggs in eight rows at the base and four at the apex, about 100 eggs in each sack.

Total length (egg strings excluded), 7 mm. Length of cephalothorax, 3.4 mm.; of trunk, 3.6 mm.; of egg strings, 4.25 mm. Width of cephalothorax, 3.15 mm.; of trunk, 3.25 mm.; of bulla, 3 mm.

Color a pale grayish-white; the bulla and pedicel brown.

Male.—Unknown.

First copepodid larva.—Cephalothorax narrower and more elongated than in *amblophitis*, bluntly rounded anteriorly and irregularly truncated posteriorly. Notches between the head and first thorax segment at about the center of each lateral margin; second thorax segment half the width of the cephalothorax, with a concave posterior margin; third segment half the width of the second, and carrying near its posterior margin on either side a single spine; fourth segment the narrowest; anal laminae relatively large, each tipped with two long and two or three small and much shorter setae; first antennae turned back along the margin of the cephalothorax. Total length, 0.92 mm. Cephalothorax, 0.7 mm. long, 0.32 mm. wide.

(*corpulentus*, stout, corpulent).

Remarks.—This species was first collected and described by Kellicott in 1880 and was called by him the gill herring-sucker.

Many specimens were obtained from different species of whitefish in Lake Erie, Lake Michigan, and Lake Ontario during the summer of 1894. These were identified by Prof. R. R. Wright, Mr. G. G. Gurley, and Dr. Richard Rathbun. Unfortunately none of the specimens appear in the collection of the United States National Museum, but the species is so common that a good supply of typical specimens of both sexes could easily be obtained. This species may be recognized by the corpulent appearance of both the head and the trunk, which are approximately the same length and width, by the large maxillipeds which reach beyond the frontal margin of the head, and by the very broad and disk-like bulla.

ACHTHERES MICROPTERI Wright.

Plate 34, figs. 64 to 67; plate 35, figs. 68 and 69.

Achtheres micropteri Wright, 1882, p. 249, pl. 2, figs. 1–11.

Host and record of specimens.—Five females from the gills of the small-mouthed black bass, *Micropterus dolomieu*, at Burton's Landing, Kankakee River, Indiana, August 19, 1909, No. 39618, U.S.N.M. Five females from gills of large-mouthed black bass, *M. salmoides*, at English Lake, Kankakee River, August 9, 1909, No. 39544, U.S.N.M. Three females from same host at Lake Maxinkuckee, Indiana, July 29, 1906, No. 39552, U.S.N.M. Fifteen males and females from the same host at Constantia, New York, April 26, 1911, presented by Dr. Tarleton H. Bean, State Fish Commissioner of New York, No. 43566, U.S.N.M. The species was reported by Wright in the paper above cited as "found in considerable numbers, both male and female, in the mouth cavity and on the gill arches of the small-mouthed black bass, *Micropterus salmoides* (Lac.) Gill," in the vicinity of Toronto, Canada.

Specific characters of female.—Head considerably smaller than the trunk, the difference being about the same as in *amblopl tis* and much greater than in *corpulentus;* dorsal carapace projecting but little at the frontal margin, relatively wider anteriorly and narrower posteriorly than in *amblopltis;* trunk broadly ovate, narrowed into a neck where it joins the cephalothorax and broadly rounded posteriorly; abdomen relatively larger than in *amblopltis*, wider at the base where it sends out a rounded lobe on either side on the dorsal surface, and more distinctly segmented; egg strings the same width as the abdomen, shorter than the trunk, and tapering toward their tips; eggs rather small, in 3 or 4 longitudinal rows, about 50 in each string.

First antennae attached some distance behind the mouth, distinctly three-jointed, the basal joint considerably the longest and stoutest, the terminal joint armed with three good-sized setae.

Dorsal ramus (endopod) of second antenna tipped with a row of toothed and sickle-shaped spines; exopod distinctly jointed and ending in a small claw. Mandible eight- or nine-toothed, the first tooth bluntly rounded, the third tooth rudimentary and very short; inner margin of the shank sharpened to a knife-edge, widest just behind the teeth. First maxillae very broad and swollen through their center, tipped with two setae, with a third one on the inner margin which is curved strongly backward.

Maxillipeds with a medium basal joint, armed near the center of the inner margin with a raised papilla covered with small spines; the terminal claw is only slightly curved and carries on its inner margin an accessory claw, behind which is a more or less prominent serrated ridge. Second maxillae closely resembling those of *amblopltis* in length, diameter, and wrinkling; bulla saucer-shaped and not fully chitinized. Spermatophores minute and spherical, sometimes fastened with so much cement as to deform the abdomen.

Color a decided yellowish-white, the yellow deepening to orange through the center of the body as the eggs ripen in the convolutions of the oviducts.

Total length (excluding egg strings), 4 to 4.5 mm. Length of cephalothorax, 1.33 mm.; of trunk, 2.66 mm.; of egg strings, 2.25 mm. Width of cephalothorax, 1 mm.; of trunk, 2 mm.

Specific characters of male.—Relatively much larger than in *amblopltis*, but having almost exactly the same shape and proportions.

First antennae slender and distinctly three-jointed; endopod of second pair with tiny and simple spines in place of the large toothed ones of the female; exopod indistinctly jointed, with a minute terminal claw; mandibles and first maxillae like those of the female; second maxillae not as long as in *ambloplitis*, less than twice as long as the maxillipeds, each tipped with a chela composed of two claws of about the same size, the tip of the anterior one shutting into a hollow in the posterior one; maxillipeds with very stout basal joints, furnished with powerful adductor and flexor muscles; on the inner side of the basal joint is a raised papilla armed as in the female.

Color, an almost snow white.

Total length, 1.5 mm. Greatest diameter of trunk, 0.34 mm.

(*micropteri*, the generic name of the host).

Remarks.—This species is fairly common on both the small- and large-mouthed black bass. The female may be distinguished from *ambloplitis* by the large abdomen, with its basal lobes and distinct segmentation, and by the much smaller egg strings. This distinction may then be confirmed by the presence of large toothed spines on the second antennae in *micropteri*, and their absence in *ambloplitis* and by the first maxillae which are three parted in *micropteri*, but only bipartite in *ambloplitis*. The male may be distinguished by its much larger size and by the chelae on the tips of the second maxillae.

ACHTHERES LACAE Krøyer.

Plate 35, figs. 70 to 74.

Achtheres lacae Krøyer, 1863, p. 274, pl. 17, fig. 6.

Host and record of specimens.—Krøyer found in the Vienna Museum two females with egg strings, which had been labelled *Achtheres lacae* by Kollar, and were said to have been taken from the mouth of a North American perch, called by Krøyer "*Perca laca.*"

Eight females with egg strings were obtained from the gills of the striped bass, *Roccus lineatus*, October 8, 1886, in the Potomac River. They are numbered 12031, U.S.N.M. One has been chosen as a surrogate type of the species and has received the number 43567, U.S.N.M.

Specific characters of female.—Cephalothorax ovoid, shorter than the trunk but considerably longer than wide; dorsal antennal area narrow, concave along the lateral margins and not continuous posteriorly. Trunk spindle-shaped or ovoid, segmentation very obscure, surface smooth and evenly rounded; abdomen in line with the thorax, small, conical, and distinctly segmented, and wholly in front of, or ventral to, the egg strings. It is one-third as wide and one-quarter as long as the trunk and shows up prominently from every point of view. Egg strings ellipsoidal, shorter than the trunk and about the same diameter as the abdomen; eggs fairly large, arranged in 6 or 7 longitudinal rows, about 15 eggs in a row. First antennae very short, not even reaching the end of the mouth-tube, with no signs of segmentation and with two minute terminal spines. Second antennae short and plump, not turned across the frontal margin, but inclined inward, the exopod considerably smaller than the endopod, two-jointed, and tipped with a pair of curved spines; the endopod one-jointed and with three or four small processes rather than spines toward the tip.

First maxillae short and plump, tipped with three setae of unequal size and without a palp; second maxillae slender, about the same length as the trunk, and united to a small and button-shaped bulla. These maxillae are fastened to the sides of the head much farther forward than in any other species, their anterior margins actually reaching the base of the second antennae.

Maxillipeds with a stout basal joint and a short and curved terminal claw; the basal joint has a small projection on its inner surface, and on the inner margin of the terminal claw is a comblike process, somewhat similar to that in *pimelodi.*

Color (preserved material), a uniform yellowish-white.

Total length (without egg strings), 4 mm. Length of cephalothorax, 1.75 mm.; of second maxillae, 3 mm.; of egg strings, 2 mm. Width of cephalothorax, 1 mm.; of egg strings, 0.55 mm.

(*lacae*, from Krøyer's specific name for the host).

Male.—Unknown.

Remarks.—Krøyer gives us very few details with reference to the appendages of this species, and he regarded the description which he gave as entirely provisional. On the other hand, he was entirely satisfied that the species was a valid one, and with the additional details here given we may regard this as established. The species agrees so closely with *pimelodi* and *percarum* that diagnostic separation seems at first difficult, but the present species may be recognized by the great size of the abdomen and by the fact that the second maxillae are attached so far forward on the sides of the head. It is also significant that the abdomen, although so large, shows no traces of segmentation

The species is evidently a rare one, and it would be particularly interesting to ascertain whether it infests this host when in the salt water.

ACHTHERES COREGONI (S. I. Smith).

Plate 36, figs. 75 to 80.

Lernaeopoda coregoni SMITH, 1874, p. 664, pl. 3, fig. 17.—KELLICOTT, 1880, p. 55, pl. 2, figs. 4 and 5.

Host and record of specimens.—Smith's original description was made from specimens found by J. W. Milner on the whitefish, *Coregonus clupeiformis* (*C. albus* Smith), at Ecorse, Michigan, and at Outer

Island in Lake Superior. Fortunately some of these specimens have been preserved and are now in the Museum collection. They are labeled by Smith himself as "Cotypes" and are numbered 39575, U.S.N.M. There is also a single specimen, a female without egg strings, taken from *Coregonus clupeiformis* at Sand Island, Lake Superior, by Milner at the same time as Smith's original types.

This may, therefore, be fairly regarded as another paratype of the species. It is numbered 38563, U.S.N.M. Kellicott reported the species as "found during the greater part of the year on the lake herring, *Argyrosomus artedi*, taken by fishermen along the Niagara River. It prefers the fins, though taken from various parts of the body." Two specimens were also taken from the kieye or chub of Lake Michigan, *Argyrosomus hoyi*, off Kenosha, Wisconsin, November 6, 1894, by C. H. Stevenson. They were identified by Gurley and are reported in his manuscript.

Specific characters of female.—The largest species of the genus with a total length, including arms and egg strings, of 17 mm. Cephalothorax in line with the trunk, broadly rounded posteriorly, strongly narrowed and elongate anteriorly, the lateral margins straight or even slightly concave. Trunk pear-shaped, narrowed to a neck where it joins the cephalothorax, obliquely truncated posteriorly, leaving a small conical projection at the center, which represents the abdomen. Trunk indistinctly segmented, showing transverse grooves and lateral indentations. Egg strings cylindrical, relatively long and narrow, straight or slightly curved toward each other at the center. Kellicott says, "In some cases I have found them to terminate in an apparent straight, sharp spine, a fifth or more as long as they." Eggs small, arranged in 4 or 5 longitudinal rows, from 100 to 125 eggs in each sack. First antennae stout, three-jointed, reaching well beyond the tip of the mouth tube, and terminated by three small setae. Second antennae with a stout basal portion and a small endopod (dorsal), which is swollen and armed with stout spines and short bristly hairs. The exopod (ventral) is indistinctly segmented and terminated by three larger curved spines, turned outward, and many smaller ones between them. Mandibles with four stout distal teeth, a smaller terminal one, and two or three small proximal ones; first maxillae small and two pointed; second maxillae long and slender, tapering regularly from the base to the tip; bulla ovoid and supported on so short a pedicel as to appear sessile; maxillipeds stout, reaching nearly to the tip of the mouth tube, terminal joint cylindrical and fleshy, the same diameter throughout and terminated by a tiny spine, the other two joints moderately swollen.

Total length (excluding egg strings), 8 mm. Length of cephalothorax, 2.5 mm.; of trunk, 5.5 mm.; of egg strings, 6 mm. Greatest width of trunk, 2.5 mm.

Color (preserved material), a uniform grayish-white.

Specific characters of male.—A single male was found by Kellicott "attached to the extremity of the female's abdomen, and so firmly that he could not be removed without mutilation." Consequently, no description was given of its general appearance or appendages, and as no other specimen has ever been obtained, it may be said that the male is unknown at the present time

(*coregoni*, the generic name of its chief host.)

Remarks.—This is undoubtedly a valid species, but there has been in the past some trouble in deciding whether the forms described by Smith and Kellicott were identical, and recently whether the *Achtheres coregoni*[1] of Baumann was really a new species or the same as that of Smith and Kellicott. Smith figures and describes the mandibles and maxillipeds, while Kellicott considered only the remaining appendages. Fortunately Smith's cotypes are available and we find that they correspond as fully with the figures and description given by Kellicott as they do with those published by Smith himself, and there can be no further doubt of the identity of these two forms. We find also that Baumann's species corresponds in all essential particulars and differs only in minor details. In fact there is no greater difference than would naturally be expected in specimens from such widely separated localities. However, the present author sent one of Smith's specimens to Doctor Baumann for comparison, and he says of it:

> Die fragliche *Achtheres*-Art hat nun allerdings den gleichen Aufenthaltsort und eine entfernte Aehnlichkeit mit der von mir beschriebenen, Zeigt aber im Bau der Mundgliedmassen Abweichungen auf die einzutreten mich zu weit fuhren wurde, die es mir aber un moglich machen, die beiden Arten zu vereinigen (p. 178).

If the two species are the same the identity of the names does no harm, but if they are distinct Smith's name will take precedence and Baumann must give his species a new name.

The species may be readily recognized by the contour of the dorsal surface of the head, by the enormous maxillipeds, each of which is nearly as large as the head, and by the narrow waist behind the base of the second maxillae. The ridges on either side of the external openings of the oviducts are also peculiar, as may be seen in figure 80, and they show up prominently in preserved specimens.

Relative to the transference of this species to the present genus, we may quote Smith's remark at the close of his description: "This species is probably not a true *Lernaeopoda*, and is perhaps the representative of an undescribed genus" (p. 665).

---

[1] Revue Suisse de Zoologie, vol. 21, No. 5, pp. 160-171, pl. 5, figs. 8-12.

ACHTHERES AMBLOPLITIS Kellicott.

Plate 25, fig. A; plate 36, figs. 81 to 85; plate 37, figs. 86 to 91.

Achtheres ambloplitis KELLICOTT, 1880, p. 56, pl. 3, figs. 6 and 7.

Host and record of specimens.—Three lots of this parasite were obtained from the gills of the red-eye, *Ambloplites rupestris*, at Lake Maxinkuckee, Indiana, and are numbered respectively 39614, 39615, and 43570, U.S.N.M. The first lot includes 5 females with egg strings, the second lot 15 females, and the third lot 100 specimens of both sexes. Since Kellicott's types have been lost, this last lot will serve as surrogate types of the species. Fifteen females were taken from the gills of "Redfish" at Big Payette Lake, Lardo, Idaho, and are numbered 39624, U.S.N.M. Gurley records the species as occurring on fully 50 of the red-eyes taken in the Shiawassee River, Michigan, a tributary of Lake Huron.

Specific characters of female.—Cephalothorax much smaller than the trunk, the separating groove being narrow and deep; ovate in outline, with a fairly well defined carapace. This carapace is wide and roundly truncated anteriorly, while the cephalothorax itself is just the reverse. It follows that where the two intersect on the lateral margins there is a shallow notch.

Trunk broadly ovate or somewhat spindle-shaped, narrowed to a short but distinct neck where it joins the cephalothorax, and tapering posteriorly to a bluntly rounded point, the abdomen.

Egg strings arising from the dorsal or dorso-lateral surface and strongly divergent, largest at the base and tapering toward the tips; eggs large, in 3 or 4 longitudinal rows, 8 or 10 eggs in each row. The genital segment between and behind the egg strings is strongly narrowed and to its posterior margin is attached the short and conical abdomen. Two spherical spermatophores, wine red in color, are often found attached to this abdomen, occupying the position usually filled by the anal laminae.

First antennae indistinctly three-jointed, long and slender, and tipped with three small setae; second antennae biramose, endopod bluntly rounded, one-jointed, and armed with tiny spines; the exopod two-jointed, narrower than the endopod, tapering quite rapidly, and armed at the tip with a single stout spine curved like a claw.

Mandible broad and stout, with six large primary teeth and a single secondary one; first maxillae consisting of a single joint, short, narrow, and bipartite at the tip; second maxillae large and stout, and in the mature adult profusely wrinkled; bulla funnel-shaped; maxillipeds with a rather stout basal joint, and a short but stout terminal claw, reenforced on the inner margin near the tip with a single spine.

The cement glands are relatively very wide, filling the whole of the dorso-lateral portions of the trunk (fig. 9). These and the remaining portions of the internal anatomy of this species have already been described under morphology (see p. 582, and following).

Color, a uniform yellowish-white, without pigment except in the egg strings, which become orange with maturity.

Total length (excluding egg strings), 4 mm. Length of cephalothorax, 1.5 mm.; of trunk, 2.5 mm.; of egg strings, 2 mm.; of second maxillae, 2 mm. Width of cephalothorax, 1 mm.; of trunk, 1.85 mm.

Specific characters of male.—Cephalothorax considerably smaller than the trunk, from which it is separated by a short waist; trunk spindle-shaped and distinctly segmented, first or basal segment the longest, the others diminishing regularly, except that the fifth segment is longer than the fourth; no anal laminae; first antennae three-jointed and tipped with two long setae; second pair biramose, the endopod curved and one-jointed, the exopod two-jointed and tipped with a claw; first maxillae relatively small, with two medium-sized setae at the tip; second maxillae slender and three times the length of the maxillipeds, the basal joint much elongated and fairly stout, the second joint short, and the terminal claw also short and slender; maxillipeds short and stout, the basal joint swollen and armed on its inner margin with a large process covered with spines, against which the short and stocky terminal claw shuts.

Color, a pale yellowish-white.

Total length, 1 mm. Greatest diameter, 0.3 mm.

The larvae and developmental stages of this species have been fully described in the ninth paper of the present series.

(*ambloplitis*, the generic name of the host.)

Remarks.—This species is as typically American as *A. percarum* is European, and is fully as widely distributed. Owing to the habits of its principal host, the red-eye, the specimens found on those fish are likely to be themselves parasitized, either by some of the Vorticellidae or by algae. Sometimes the body of the copepod is so completely covered that it looks as if it were clothed in fur. At other times it has, seemingly, long tufts of hair on its head or rump, or even on the second maxillae.

The species may be recognized by its small size, relatively short and spindle-shaped body, short and plump egg strings, the prominence of the second antennae, and the pattern of the dorsal surface of the head. As Kellicott observes, it lives chiefly on the inner surface of the gill arches, which in the red-eye are covered with teeth. The copepods, especially the younger and undeveloped stages, are so small and so mingled with the gill teeth as to be easily overlooked. But careful examination of the gill arches of almost any red-eye will reveal some of the parasites, and often many are found together on the same fish.

ACHTHERES PIMELODI Krøyer.

Plate 38, figs. 92 to 95.

Achtheres pimelodi Krøyer, 1863, p. 272, pl. 17, fig. 5*a* and 5*b*.

Host and record of specimens.—A few young females with egg strings were obtained by Krøyer from the mouth of the channel catfish, *Ictalurus punctatus* (called by Krøyer *Pimelodus maculatus*), taken at Cincinnati, Ohio, in 1854. Two adult females were obtained by the author from the gill arches of the catfish, *Ameiurus nebulosis*, at Put-in-Bay, Ohio, July 7, 1908. They have received the number 39560, U.S.N.M. A single male was obtained from the inside of the operculum of the Fulton cat, *Ictalurus anguilla*, at Fairport, Iowa, in July 1914; this has been numbered 47726, U.S.N.M.

Specific characters of female.—General form plump and swollen; cephalothorax almost spherical, a little longer than wide and truncated anteriorly, its lateral margins slightly concave, not in line with the trunk but inclined at an obtuse angle. Trunk pyriform or spindle-shaped in the young females, and flattened dorso-ventrally, with two longitudinal furrows on the dorsal surface; distinctly segmented, the fifth segment much shorter than the others. Abdomen small, conical, inclined ventrally and made up of two segments, the terminal one much smaller than the basal.

In the mature adult the segmentation largely disappears, together with the longitudinal furrows, and the abdomen is more or less absorbed into the genital segment. No visible anal laminae, but Krøyer mentions a pair of very small, blunt, two-segmented (?) lobes at the posterior corners of the abdomen, which are apparent only under pressure. Egg strings as long as the entire animal and linear; eggs large, arranged in two or three rows, from 16 to 20 eggs in a row.

First antennae directed obliquely outward and forward, slender, pointed, and indistinctly segmented; second antennae large and plump and turned down across the frontal margin; basal portion made up of two equal segments; exopod (ventral) two-jointed and armed at the tip with a small spine; first maxillae very small and plump, each tipped with two setae; second maxillae slender, cylindrical, and nearly uniform in size for their entire length; bulla small, cup-shaped, and practically sessile; maxillipeds with a medium basal joint having a knob or swelling on the inner margin; terminal claw much shorter than the basal joint, with a sort of comb made up of three accessory spines on its inner margin.

Color, a uniform grayish-white.

Total length (excluding egg strings), 2.8 mm. Length of cephalothorax, 1 mm.; of trunk, 1.8 mm.; of egg strings, 3 mm. in the young, 2 mm. in adults. Width of cephalothorax, 0.90 mm.; of trunk, 1.4 mm.

Specific characters of male.—Cephalothorax relatively wider than in *amblopltis*, and not separated as distinctly from the trunk, the two in the same straight line; trunk spindle-shaped and indistinctly segmented, with a pair of small, claw-shaped anal laminae, curved dorsally; first antenna four-jointed, the second joint nearly as long as the other three, tipped with three short setae; second antenna biramose, the basal portion two-jointed, the joints at an angle with each other, the endopod (dorsal) one-jointed, short, thickset, and terminated by a single spine, the exopod (ventral) two-jointed, the terminal joint inclined dorsally and armed with a large curved claw at the upper distal corner, and three small spines along the distal margin; first maxillae slender and tipped with two stout setae jointed near their bases, palp a mere knob on the inner margin tipped with a minute papilla; second maxillae much longer than the maxillipeds, rather slender but with strong muscles and ending in stout claws; maxillipeds with a swollen basal joint carrying on its inner margin a corrugated process against which the short terminal claw shuts.

Total length 2.15 mm. Greatest diameter 0.52 mm.

Color, a uniform grayish-white.

(*pimelodi*, Krøyer's generic name for the host.)

Remarks.—It is evident from Krøyer's description that his specimens were young females and not fully grown adults. This may be seen in the distinct segmentation, the remnants of the anal laminae and swimming feet, which he mentions as being found on the abdomen and the first thorax segment, respectively. The adults here presented agree so completely in all their general details as to leave no doubt of their identity. The points in which they differ are just those that would be looked for in the two stages of development—a disappearance of the swimming feet, body segmentation, and anal laminae, and a fusion of the abdomen with the trunk. Hence the presence of these differences confirms rather than disparages the identity of the two.

Probably also the "*Achtheres* sp." mentioned by Wright in the Report of the Ontario Game and Fish Commission for 1892 (p. 438, fig. 10, text), is the same as the present species.

It is evidently not a very common species since the examination of hundreds of catfish by the present author yielded only the three specimens mentioned above.

ACHTHERES PERCARUM Nordmann.

Plate 39, figs. 96 and 97.

Achtheres percarum Nordmann, 1832, p. 63, pl. 4, figs. 1–11; pl. 5, figs. 1–12.—Claus, 1862, p. 287, pls. 23 and 24.

Host and record of specimens.—The United States National Museum collection contains two lots of this species, the first containing nine females without egg strings, taken from the mouth of *Lucoperca* in the Danube River at Hesse, Germany. This lot is numbered 39576, U.S.N.M.

A second lot of two females with egg strings was taken from the gills of *Perca fluviatilis* at Yamtland, Sweden, and was obtained by exchange with the University of Stockholm. It has been numbered 43580, U.S.N.M.

Specific characters of female.—Cephalothorax nearly as large as the body and ovate, inclined at right angles to the trunk axis, the trunk as wide as long and distinctly segmented, obovate in outline and flattened dorso-ventrally; abdomen small, triangular and without joints; each egg string often as large as the body and ellipsoidal, containing about 75 eggs. First antennae slender, exceptionally long, and distinctly three-jointed; second pair with a simple exopod, armed with short spines and considerably curved toward the endopod; the latter also simple and tipped with a single spine; first maxillae three-partite, the three rami all on a level; second maxillae stout and tapered considerably anteriorly; bulla as wide as both arms at their tips and cup-shaped; claw on the maxillipeds smooth and rather slender.

Color, a grayish-white.

Total length (without egg strings), 4.5 mm. Length of cephalothorax, 2.2 mm.; of trunk, 2.3 mm.; of egg strings, 2.5 mm. Width of cephalothorax, 2 mm.; of trunk, 2.3 mm.; of egg strings, 1.66 mm.

(*percarum*, the generic name of the host.)

Specific characters of male.—Cephalothorax fully as long as the trunk, widest posteriorly, with concave lateral margins; body indistinctly segmented, a flattened sphere in shape, ending in a blunt tip posteriorly, where it is armed with two short anal laminae. First antennae very slender and three-jointed as in the female; neither ramus of the second pair armed as well as in the female; first maxillae three-partite; second maxillae long, with a wrinkled basal joint and a small chela on the tip of the terminal joint; claw of maxillipeds short and stout, shutting down against a small papilla on the inner margin of the basal joint.

Color, a creamy white.

Total length, 1.5 mm. Greatest width, 0.66 mm.

Remarks.—Both sexes of this species have been admirably described and figured by both Nordmann and Claus, the latter also giving the internal anatomy and several stages in the development. Hence there have been here included only the distinguishing characters and two outline figures for comparison. These plainly show that it is different from all the American species, and thus far it has never been found upon any American host, although it is widely distributed throughout Europe. Like the American species, *amblopliti*s, it is much infested with parasitic Vorticellidae and algae, and specimens are often found completely covered with these plants and animals.

Genus LERNAEOPODA Blainville.

Generic characters of female.—Cephalothorax more or less inclined to the trunk axis, short, thickset, and covered with a distinct dorsal carapace; first one or two thorax segments well differentiated, the others thoroughly fused with one another and with the abdomen; no anal laminae; genital process minute; a posterior process on either side of the genital process and ventral to the egg strings. First antennae four-jointed; exopod of second antenna much smaller than the endopod and two-jointed; mandibles slender, teeth bluntly rounded or even truncated; first maxillae tipped with three setae, sometimes jointed; palp present, with three terminal setae; tips of the second maxillae enlarged into disks or furnished with a bulla; egg strings long and slender.

Generic characters of male.—Size unusually large (2 to 3.5 mm.); cephalothorax more or less inclined to the trunk axis, separated from the trunk by a well-defined groove and covered with a dorsal carapace; trunk of young males conical and segmented, later becoming inflated and losing its segmentation; anal laminae often exceptionally large and turned forward dorsally. First antennae four-jointed; second antennae chelate; second maxillae with a large spinous process on the basal joint, forming a chela with the terminal claw; maxillipeds much larger and stouter than the maxillae.

Type.—*Lernaeopoda brongniartii* Blainville.

(*Lernaeopoda*, *Λερνᾶιος*, Lernaean and *πούς*, foot).

Remarks.—This genus was founded by Blainville in 1822, with the type-species *L. brongniartii*, specimens of which he observed "in the collection of Brongniart, who did not know where or on what kind of a fish they had been obtained" (p. 442). He also included with the type the species *salmonea* of Gissler, of which, however, he said that he had never seen a specimen, and that possibly it did not belong to this genus. An examination of the two species quickly convinces one that they belong to different genera, as here indicated. Although Blainville's type has never been seen by any other observer, it was described and figured well enough to show its relationship to Grant's species, *elongata*, and Krøyer's species, *galei*. These two species are very well known, and have been repeatedly described and figured; taken together, therefore, they will serve as a sort of common coenotype of the genus, and will illustrate for us its chief characters.

With these three species we may retain in the original genus Thomson's *musteli*, Kane's *bidiscalis*, and Richiardi's *scyllii*, making six in all. The five of these whose hosts are known are all parasites on the genital apparatus, or the eyes of sharks.

The other species which have from time to time been referred to this genus must be transferred to the new genera, *Lernaeopodina* and *Salmincola*, or they prove to be synonyms. If the number left in the original genus seems small while those transferred to other genera is unduly large, we must remember that hitherto practically no attention has been paid to the structure of the male. Furthermore, this genus with *Clavella* (*Anchorella*), has for years served as a dumping ground for such species as could not with certainty be located anywhere else. And, finally, if we could select *salmonea* as the type of Blainville's genus we could still retain the majority of the species in the original genus. But Blainville never even saw a specimen of *salmonea*, so that we are obliged to abide by the decision, even though it does cause so many changes.

Accordingly we transfer to the new genus *Salmincola* the following species, because they have no dorsal carapace, no free thorax segment, no posterior processes, no palp on the first maxillae, while the rami of the second antennae are unsegmented. *L. alpina* Olsson, 1877, p. 82, pl. 5, figs. 10 to 13; *arcturi* Miers, 1877, p. 106, pl. 4, fig. 2; *beani* Wilson, 1908, p. 470, pl. 81; *bicauliculata* Wilson, 1908, p. 472, pl. 82; *californiensis* Dana, 1852, p. 1379, pl. 96, fig. 1, *a* and *b*; *carpionis* Krøyer, 1837, p. 268, pl. 2, fig. 6; *edwardsii* Olsson, 1869, p. 36; *extumescens* Gadd, 1901, p. 100; *falculata* Wilson, 1908, p. 473, pl. 83; *gibber* Wilson, 1908, p. 469, pl. 80; *inermis* Wilson, 1911, p. 632, pl. 68, figs. 33 to 36; *lotae* Olsson, 1877, p. 84, pl. 6, figs. 14 to 19; *maraenae* Olsson, 1877, p. 80, pl. 5, figs. 6 to 8; *salmonea* (Gissler), 1751, p. 185, pl. 6, figs. 1 to 5; *siscowet* Smith, 1874, p. 664, pl. 3, figs. 15 and 16; *thymalli* Kessler, 1868, p. 97, pl. 4, fig. 3, *a* and *b*.

L. bicaudata Krøyer, 1837, p. 275, pl. 3, fig. 11, is transferred to the genus *Charopinus* (see p. 656).

L. clavigera Olsson, 1872, p. 63, pl. 5, figs. 1 to 6, is the same species that had been described four years before by Kessler under the name *L. thymalli* (see p. 613).

L. cluthae T. Scott, 1900, p. 173, pl. 8, figs. 27 to 37, is shown by the form and segmentation of the male to belong to the genus *Charopinus* (see p. 654).

L. coregoni Smith, 1874, p. 664, pl. 3, fig.17, belongs to the genus *Achtheres*, as has already been shown on p. 623.

L. coregonorum and *L. extensa* were established by Kessler in a paper entitled Materials toward a Knowledge of the Onega Sea and the District about it, particularly in its Zoological Aspects. They are both described on p. 97 and figured on plate 4, figs. 1 and 2. After a careful examination of these figures and a condensed description of the same species given by Gadd in 1904 it is certain that neither of the species belongs to the genus *Lernaeopoda* as here constituted. They have no dorsal carapace, no differentiated thorax segments, no posterior processes, and no palp on the first maxillae. They do agree, however, in all known particulars with the new genus *Salmincola,* and accordingly are transferred to that genus.

L. cyprinacea Hermann, 1783, pl. 2, fig. 7, is a synonym of Gissler's *L. salmonea.*

L. dalmanni (Retzius), 1829, p. 109, pl. 6, belongs to the genus *Charopinus* (see p. 655).

L. fontinalis Smith, 1874, p. 663, pl. 3, figs. 12 to 14, is a synonym of Olsson's *L. edwardsii.*

L. (?) *lampri* T. and A. Scott, 1913, p. 202, pl. 33, fig. 6; pl. 49, figs. 12 to 16, if compared with the male shown in fig. G will be found to agree so closely as to leave no doubt that the species belongs to the genus *Thysanote* rather than to *Lernaeopoda* (see p. 650).

L. longibrachia Brian, 1912, p. 39, pl. 2, fig. 5; pl. 12, figs. 1 to 12, and *L. longimana* Olsson, 1869, p. 38, pl. 2, figs. 18 to 22, have no dorsal carapace and no free thorax segment, both rami of the second antennae are unsegmented, and the posterior processes are dorsal instead of ventral. For these reasons they are transferred to the new genus *Lernaeopodina* (see p. 640).

L. musteli Thomson, 1889, p. 373, pl. 28, figs. 9 and 9*a*, is founded on a single female, has never been seen by any other investigator, and no data are given with reference to the appendages, so that it can not be located anywhere with certainty, but is possibly a synonym of *L. galei.*

L. obesa Krøyer, 1837, p. 270, pl. 3, fig. 13, *a* to *c*, was shown by Olsson to belong to the genus *Brachiella* (see p. 701).

L. scyllii Richiardi, 1880, p. 151, was a mere name without description or figures, but Brian identified it in 1899 and gave a text figure of the female. If his identification is right, the species is a synonym of *L. galei.*

L. sebastis Krøyer, 1863, p. 279, pl. 17, fig. 7, *a* to *h*, is founded upon two mutilated specimens obtained from a Greenland fish and has never been seen by any other investigator. It presents several details which are radically different from the genus as here established, notably in the structure of the second antennae and first maxillae, as well as in the absence of posterior processes and a dorsal carapace. The two appendages which look like posterior processes in Krøyer's figure are stated in his description to be spermatophores. There are enough of these differences to exclude the species from the genus *Lernaeopoda,* but not enough to enable us to locate it anywhere else with even a probability. Hence the best that can be done is to leave it until further details can be obtained.

L. similis T. and A. Scott, 1913, p. 202, pl. 61, figs. 5 and 6, has no dorsal carapace, no free thorax segment, and the posterior processes are dorsal. These facts with other details warrant its transfer to the new genus *Lernaeopodina*.

L. spinacis Brian, 1912, p. 36, pl. 5, fig. 8; pl. 11, figs. 3 to 6, shows in the male a structure entirely distinct from *Lernaeopoda* and is accordingly transferred to the new genus *Lernaeopodina*.

L. stellata Blainville, 1823, p. 112, was figured by Milne Edwards, 1840, pl. 40, fig. 12, but has never been well enough described to be located anywhere definitely.

TABLE OF SPECIES.

1. Ends of second maxillae enlarged into flattened disks; no bulla; posterior processes foliaceous .... 2.
1. Ends of second maxillae united to a button-shaped bulla; posterior processes usually cylindrical, sometimes foliaceous .... 3.
2. Second maxillae filiform; terminal disks mere flattened claws; maxillipeds with stout chelae; posterior processes turned forward ventrally. *brongniartii* Blainville, 1822, p. 634.
2. Second maxillae stout, terminal disks three times the diameter of the maxillae; maxillipeds with a simple, slender claw........... *bidiscalis* Kane, 1892, p. 635.
3. Size small (5 mm.); neck short and indistinct; posterior processes filiform; second maxillae longer than the trunk; can not be located with certainty. *musteli* Thomson, 1889, p. 635.
3. Size medium (12 mm.); neck distinctly segmented; posterior processes stout, sometimes foliaceous; second maxillae two-thirds the length of the trunk. *galei* Krøyer, 1837, p. 635.
3. Size large (20 mm.); neck distinctly segmented; posterior processes mere knobs; second maxillae two or three times the length of the trunk. *elongata* (Grant), 1827, p. 637.

LERNAEOPODA BRONGNIARTII Blainville.

Lernaeopoda brongniartii Blainville, 1822, p. 442, figs. 15 and 15*a*.

Generic characters of female.—Since this was Blainville's type species, and since it has been seen by no other observer, it seems best to translate Blainville's original description, explaining in parentheses the appendages and parts designated:

> Body slender, quite elongate, divided into an oval abdomen (trunk) and a cephalothorax, flattened and covered with a hard carapace; a pair of palps (first maxillae), short, stout, conical, and subarticulate, accompany the mouth; two pairs of legs (second maxillae and maxillipeds), articulated and furnished with claws, on the thorax; egg sacks short and subcylindrical. The anterior pair of legs (maxillipeds) short and formed of two joints and one claw; the posterior pair (second maxillae) much the longer, slender, cylindrical, with a terminal flattened, triangular claw. . . . .
>
> The abdomen (trunk) is oval and a little flattened. The two sacks with which it terminates behind are covered with a horny skin, somewhat transparent, which permits one to see that their interior is filled with a hepatic substance, fully resembling that in the abdomen. The long legs (second maxillae) were made up in the same way.

To this may be added that the cephalothorax is inclined to the trunk while the posterior processes, or sacks, as Blainville calls them, are turned forward, or ventrally, at right angles to the trunk axis. Furthermore, Blainville's second figure shows that the exopod of the second antennae is segmented, and that the claws on the maxillipeds are chelate.

Total length, 13 or 14 mm. Length of cephalothorax, 4 mm.; of trunk, 10 mm.; of posterior appendages, 4.5 mm. Width of trunk, 5 mm.

(*brongniartii*, to Prof. Alexandre Brongniart, of the Faculty of Science at Paris).

LERNAEOPODA BIDISCALIS Kane.

Lernaeopoda bidiscalis KANE, 1892, p. 203, pls. 9 and 10.

Remarks.—This species was obtained by Kane from the claspers of male topes, *Galeus vulgaris*, caught off the coast of Ireland in 1890, and both sexes were admirably described and figured. The female agrees in all essential generic particulars with the one described by Blainville, and the male is taken as the type male of the genus (see pl. 25, fig. B). Attention is called to the fact that in both of these species there is no bulla, and that the posterior processes are foliaceous. In the undeveloped young of both sexes the trunk shows distinct segmentation.

LERNAEOPODA MUSTELI Thomson.

Lernaeopoda musteli THOMSON, 1889, p. 373, pl. 28, figs. 9 and 9*a*.
Achtheres galei BRIAN, 1906, p. 101.

Remarks.—This species was described by Thomson from a single specimen taken from the cloaca of the smooth hound, *Mustelus antarcticus*, near New Zealand. Neither the description nor the figures give us sufficient data for a definite location of the species. We have no details of any of the appendages or mouth parts, and the single figure (9*a*) of the under surface of the cephalothorax is so small that it gives only the relative position of the various organs. Brian in the reference given above makes this species, Richiardi's *Lernaeopoda scyllii*, and Kurz's *Achtheres selachiorum*, all synonyms of Krøyer's *Lernaeopoda galei*, but he changes the genus of Krøyer's species and calls it *Achtheres galei*. The male of *L. galei* shows conclusively that it can not be included in the genus *Achtheres*, and the absence of an abdomen and the presence of posterior processes in the females of the other species debar them from the same genus. The only thing that we can do with this species described by Thomson is to leave it where he placed it until we can get further details.

LERNAEOPODA GALEI Krøyer.

Lernaeopoda galei KRØYER, 1837, p. 272, pl. 3, fig. 5, *a* to *f*.—BAIRD, 1850, p. 334, pl. 35, fig. 7.—T. SCOTT, 1900, p. 172, pl. 8, figs. 16 to 25.

Host and record of specimens.—In the collection of the United States National Museum there is a single female of this species, with attached males. They were taken from a smooth hound at Cornwall, England, and were obtained by exchange from Rev. A. M. Norman; they are numbered 8346, U.S.N.M.

Specific characters of female.—Cephalothorax comparatively very small, oval in outline, strongly flattened dorso-ventrally, and covered with a distinct dorsal carapace. Trunk slender, obclavate, narrowed where it joins the cephalothorax and with the first one or two thorax segments well differentiated; broadest and thickest at the posterior end, which is well rounded and terminates in two cylindrical processes, on a level with the ventral surface and somewhat divergent; between these processes on the median line is a small genital process; egg strings narrow and as long as the body; eggs large and somewhat flattened anteroposteriorly, arranged in 4 to 6 longitudinal rows, about 150 eggs in each string. Basal joint of first antenna much enlarged, the other three joints diminishing regularly in size. Exopod of second antennae only one-fourth the diameter of the endopod, distinctly two-jointed, and ending in several short spines. First maxillae tripartite, one ramus terminal, the other two on the inner margin, palp well developed and tipped with two short and curved spines. Second maxillae as long as the trunk, slender, cylindrical, and slightly swollen at the tip, where they are furnished with a small bulla. Maxillipeds situated between the bases of the second maxillae, with a stout basal joint armed on the inner margin with two rounded knobs covered with spines, terminal claw rather slender, with a bunch of accessory spines near its tip.

Color, a uniform grayish-white, but varying greatly in specimens from different hosts and also in different specimens from the same host. Van Beneden (1851, p. 120) obtained this species from four different genera of Plagiostoma, *Mustelus*, *Trygon*, *Galeus*, and *Scyllium*. He notes that some of the parasites had yellow bands on the heads, antennae, second maxillae and maxillipeds, in others these organs were all of a bright red color, while in still others this same red color was confined to the anterior part of the thorax. Similar colors are found in certain of the Lernaeidae whose attachment organs are buried in the tissues of the host, and both there and in the present species the color is remarkably permanent, withstanding strong alcohol for many years.

Total length, 10 to 15 mm. Length of cephalothorax, 1.5 mm.; of trunk, 9 mm.; of posterior processes, 2 mm.; of egg strings, 10 mm.

Specific characters of male.—Cephalothorax in line with the trunk axis, half the entire length, considerably larger than the rest of the body, and covered with a distinct dorsal carapace. Trunk cylindrical, slightly increased in diameter at the center and indistinctly segmented; toward the posterior end on the ventral surface may be seen the two genital openings for the extrusion of the spermatophores; behind these but thoroughly fused with the trunk is a small unsegmented abdomen, which carries a pair of anal laminae attached to its posterior margin on a level with the dorsal surface. These are narrowed into a slender neck where they join the abdomen, then swell suddenly into a plump, somewhat flattened cylinder which is short and pointed at the tip and is turned forward along the dorsal surface of the body.

The appendages are similar to those of the female, except that both the second maxillae and maxillipeds are chelate, the terminal claw shutting against a curved spine or process on the inner margin of the second joint.

Color, a uniform yellowish-white.

Total length, 2.15 mm. Greatest diameter, 0.65 mm.

(*galei*, from the generic name of the most common host.)

Remarks.—This male is one of the largest in the entire family and it seems to prefer to attach itself to the body of the female at the anterior end and just behind the cephalothorax instead of at the posterior end. Scott reports this species as found in company with *bidiscalis* upon the male tope, *Galeus canis*. The present species adhered to the skin beneath and between the ventral fins, while *bidiscalis* was found adhering to the ends of the claspers.

LERNAEOPODA ELONGATA (Grant).

Plate 39, fig. 98.

Lernaea elongata GRANT, 1827, p. 147, pl. 2, fig. 5.
Lernaeopoda elongata KRØYER, 1837, p. 259, pl. 2, fig. 12.—BAIRD, 1850, p. 333, pl. 35, fig. 5.—T. SCOTT, 1900, p. 171, pl. 8, figs. 11 to 15.

Host and record of specimens.—Three fine females, two of which have attached males, are numbered 12037, U.S.N.M., but there is no record of the host or locality. Another female was obtained in Greenland by N. P. Scudder and is numbered 39574, U.S.N.M. No host is given for this specimen, but as it was obtained from the fishermen off the coast it was probably taken from a shark. All four of these females have unbroken egg strings.

Specific characters of female.—Cephalothorax small, ovoid, flattened dorso-ventrally, and inclined at right angles to the trunk axis. First two segments of the trunk distinctly differentiated, the others merely indicated by surface grooves; trunk cylindrical, more or less strongly flattened dorso-ventrally, two or three times as long as wide, with a row of pits or depressions along either side of the dorsal midline; the posterior end with prominent well-rounded corners, and in the center between the bases of the egg strings and on a level with the ventral surface two short knoblike posterior processes. Egg strings considerably longer than the body, slender, and cylindrical; eggs minute, arranged in 20 to 30 longitudinal rows, about 100 eggs in a row.

First antennae four-jointed, rather slender; second pair with a tiny exopod inserted on the side of the endopod, the former tipped with four spines, the latter smooth. Mandibles slender, with eight comblike teeth, all of the same size; first maxillae tipped with three jointed setae, palp long and tipped with three spines.

Second maxillae long and stout and more or less wrinkled, jointed at the tip by a button-shaped bulla. These maxillae are attached to the sides of the head, on a level with the dorsal surface, and just outside the bases of the maxillipeds. The latter have a moderately stout basal joint, carrying a short process on its inner margin, which is covered with bristling hairs; terminal claw short and slender, with an accessory spine on the inner margin near the tip.

Color (preserved material), a uniform yellowish-white, the pitted areas brownish, the egg strings orange.

Total length (without egg strings), 22 mm. Length of second maxillae, 14 mm.; of egg strings, 25 mm. Greatest width, 5 to 7 mm.

Specific characters of male.—Cephalothorax inclined to the trunk axis nearly at right angles and covered by a well-defined carapace; trunk conical and distinctly segmented in younger specimens, but thickening posteriorly and losing its segmentation in older specimens; in both it is about the same length as the cephalothorax and terminates in two small spinelike anal laminae, curved backward along the dorsal surface. First antennae four-jointed, slender; second pair, chelate, the endopod ending in a leaflike lamina, smooth and unarmed, the exopod with a small terminal lamina bifid nearly to its center. First maxillae tipped with two long setae and a shorter one on the inner margin; second maxillae rather stout and tipped with a stout claw; maxillipeds also stout, the terminal claw curved and fitting against a process on the basal joint, making a powerful chela.

Color (preserved material) a uniform yellowish-white.

Total length, 2.5 mm. Length of cephalothorax, 1.2 mm. Greatest width, 0.75 mm.

(*elongatus*, elongate, alluding to both the trunk and the egg strings.)

Remarks.—The male described by Steenstrup and Lütken differs from the two found upon the present females chiefly in the inflation and segmentation of the trunk. In their specimen the trunk was almost spherical and showed no traces of segmentation; in the present specimens it tapers decidedly backwards and is distinctly segmented. But these are just the differences one would expect between young and fully developed males.

The minute size and enormous number of the eggs is also worthy of notice. Possibly the copepodid larvae can not attach themselves to any other portion of the host's body except the eye where they are always found. If this be true, it would greatly restrict their chances of survival and so would necessitate a much larger number of eggs.

LERNAEOPODINA, new genus.

Generic characters of female.—Cephalothorax at an oblique angle with the trunk, much smaller than the latter, and the two separated by a distinct groove; dorsal carapace small and poorly defined; trunk pear-shaped, much narrowed anteriorly; no anal laminae, but two small posterior processes dorsal to the egg strings; no genital process or external segmentation; first antennae three-jointed; second antennae biramose, the rami about the same size, unsegmented, and covered with bristles and spines; first maxillae bipartite, with a short palp; second maxillae slender, bulla button-shaped; maxillipeds with slender terminal claw, having an accessory claw on the inner margin; egg strings short and stout.

Generic characters of male.—Body bent twice at right angles, so that the trunk and the anterior portion of the cephalothorax are parallel with the second maxillae and maxillipeds; trunk separated from the cephalothorax by a well-defined groove, unsegmented, and terminating in two anal laminae, each tipped with a small spine; first antennae three-jointed; second antennae biramose but not chelate; first maxillae slender, without a palp and tipped with two setae; second maxillae and maxillipeds very large and stout, and armed with strong chelae.

Type.—*Lernaeopodina relata*, new species.

(*Lernaeopodina*, *Lernaeopoda* and ending denoting likeness.)

Remarks.—It will be noted that the species belonging to this new genus are parasitic on rays and sharks which inhabit the deeper portions of the ocean. Brian called attention to this fact in connection with the two new species which he established in 1912 (p. 38). And it may be still further emphasized by the three species taken from deep water rays, Olsson's *longimana*, T. Scott's *cluthae*, and the new species, *relata*. There must be the same adaptation to pressure in the parasites which obtains in the fishes serving as their hosts. This fact ought to have some systematic value in indicating the close relationship of these species. The simplest way to distinguish the genus from *Lernaeopoda* is by the posterior processes in the female which are dorsal to the egg strings instead of ventral. To this may be added the equal size of the rami of the second antennae, both of which are unsegmented, while the first maxillae are bipartite. The *Lernaeopodina* male is very much smaller than that of *Lernaeopoda*, and its body is bent twice at right angles, the cephalothorax has no carapace, and the second maxillae as well as the maxillipeds are chelate.

Lernaeopoda cluthae T. Scott, 1900 (p. 173), is referred to this new genus for several reasons. It has no dorsal carapace, no differentiated thorax segments, the posterior processes are dorsal instead of ventral, and the male is radically different from that of *Lernaeopoda*, so that it can not belong to that genus.

On the other hand the female agrees with that of *Lernaeopodina* in every particular except the segmented exopod of the second antennae, and the male corresponds save for the fact that the trunk is segmented. This latter is probably due to the stage of development of the male, since we find similar differences in every genus in the family where the males are known.

We are thus left with the single difference mentioned in the female and may refer the species to the present genus.

Lernaeopoda similis T. and A. Scott, 1913, p. 202, for the same reasons just enumerated can not remain in the genus where it was placed. No details are given of the appendages or mouth parts, nor is the male known, yet the excellent colored figures and the brief description leaves but little doubt that the species belongs here in the new genus rather than in *Lernaeopoda*.

Lernaeopoda spinacis Brian, 1912, p. 36, is also transferred to the present genus. Brian described and figured both sexes of this species, and while the male agrees with that of *Lernaeopodina* in all essential particulars, the female differs in the fact that it has no posterior processes. This is an important difference but not enough to warrant the erection of a new genus, and as the species shows greater affinity with *Lernaeopodina* than with any other genus in the family it is placed here.

TABLE OF SPECIES.

1. Second maxillae filiform and definitely longer than the trunk.................. 2.
1. Second maxillae stouter and definitely shorter than the trunk................ 3.
2. Second maxillae three times the length of the trunk; posterior processes cylindrical and half as long as the trunk; maxillipeds small and weak. *longibrachia* (Brian), 1912, p. 641.
2. Second maxilae but little longer than the trunk; posterior processes flattened and foliaceous; second antennae chelate; maxillipeds large and strong. *longimana* (Olsson), 1869.
2. Second maxillae but little longer than the trunk; posterior processes cylindrical, but less than one-fourth the length of the trunk; second antennae simple; maxillipeds large and strong....................*cluthae* (T. Scott), 1900.
3. Cephalothorax much elongated; posterior processes conical, slender; egg strings slender and as long as the trunk; dorsal carapace very indistinct. *similis* (T. and A. Scott), 1913.
3. Cephalothorax short and wide; posterior processes stout, cylindrical; egg strings stout and only half the length of the trunk; dorsal carapace well defined. *relata*, new species, p. 641.
3. Cephalothorax short, wide, and depressed; posterior processes mere knobs; egg strings stout and as long as the trunk; dorsal carapace well defined. *spinacis* Brian, 1908.

LERNAEOPODINA LONGIBRACHIA (Brian).

Lernaeopoda longibrachia BRIAN, 1912, p. 39, pl. 2, fig. 5; pl. 12, figs. 1–12.

Host and record of specimens.—There is in the collection of the United States National Museum a single female of this species, which is numbered 6087, U.S.N.M., but unfortunately all record of host and locality has been lost.

Specific characters of female.—Brian has given a good description and figures of this species, and we may repeat briefly the principal characters. Cephalothorax comparatively small, one-fifth the length and one-fourth the width of the trunk, obovate, covered with a distinct dorsal carapace, and well separated from the trunk; neck short and without grooves; trunk pear-shaped, increasing in diameter from the narrow neck backward, plumply rounded and smooth. A small and degenerate abdomen between the posterior processes; the latter cylindrical, half as long as the trunk, and contracted into a narrow pedicel where they join the thorax. Egg strings cylindrical, half the diameter of the body, and four-fifths as long; eggs small, in 10 or 12 longitudinal rows, about 45 in a row. First antennae four-jointed; second antennae biramose, the endopod (dorsal) somewhat larger than the exopod (ventral), neither of them jointed. First maxillae minute, without a palp and tipped with two setae; second maxillae filiform, of the same diameter throughout, and from two and a half to five times the combined length of the cephalothorax, trunk, and posterior appendages. Maxillipeds rather slender, with a stout spine on the basal joint near the distal end, and an accessory spine on the inner margin of the terminal claw near its tip.

Color (preserved material), a light brownish-yellow.

Total length (without posterior processes), 11 mm. Length of posterior processes, 3 mm.; of egg strings, 11 mm.; of second maxillae, 55 mm. Greatest width of trunk, 5 mm.

(*longibrachia*, long-armed, alluding to the second maxillae.)

Remarks.—The distinguishing character of this species is the remarkably long and slender second maxillae, which, as Brian has stated, give the parasite the appearance of a tiny pear suspended by two long threads. No other copepod is known in which the attachment organs reach such a proportionate length.

LERNAEOPODINA RELATA, new species.

Plate 25, fig. D; plate 39, figs. 99 to 101; plate 40, figs. 102 to 105.

Host and record of specimens.—About one hundred specimens of both sexes were obtained from the gills of a large barndoor skate, *Raja levis*, at Harpswell, Maine, August 15, 1913. A single female with an attached male is made the type of the new species and is numbered 43572, U.S.N.M. The remaining specimens are numbered 43576, U.S.N.M., and become paratypes.

Specific characters of female.—Cephalothorax short and wide and separated from the body by a well defined groove, the anterior portion covered with a dorsal carapace; trunk pear-shaped, narrowed anteriorly into a long slender neck, prolonged posteriorly into a bluntly rounded point between the egg strings, which represents the abdomen; on either side of this point, and dorsal to the egg strings, is a short cylindrical process, half a millimeter long and curved like a parenthesis mark; they are of the same diameter throughout, with a slight constriction at the base; egg strings only one-third as long as the trunk, but plump; eggs large, in 4 or 5 longitudinal rows, about 10 in each row.

First antennae plump and almost entirely concealed by the second pair, indistinctly jointed and terminated by three short spines. Second antennae large and stout, inclined inward against the mouth tube, and biramose at the tip, the two rami well separated, unsegmented, and curved toward each other at their tips, each armed with one or two stout spines and many smaller ones. First maxillae slender and tipped with two setae; palp short and thick, and also tipped with two setae. Second maxillae about twice the length of the cephalothorax, slender and joined at the tip to a small, button-shaped bulla. Maxillipeds large and stout, the terminal claw long and slender, with an accessory claw on the inner margin, close to the tip, followed by a row of saw teeth; a large roughened knob on the inner margin of the basal joint near the distal end, against which the terminal claw shuts. Color, a uniform creamy white, the bulla transparent. Total length, including posterior processes, 5 mm. Length of cephalothorax, 1.2 mm.; of egg strings, 1.75 mm.; of second maxillae, 3 mm. Greatest width of trunk, 1 mm.

Specific characters of male.—Anterior portion of cephalothorax and trunk parallel with each other and with the second maxillae and at right angles to the posterior portion of the cephalothorax; no carapace; trunk conical, tapering rapidly backward, unsegmented, terminating in two short processes, each tipped with a single spine; in side view the trunk does not project beyond the maxillipeds and looks like a third pair of appendages.

First antennae three-jointed; second pair biramose, the rami curved toward each other, and each armed with two stout spines. First maxillae swollen at the base, slender at the tip, terminating in two long setae; no palp; second maxillae slender and tipped with a stout claw, which shuts past a spine on the basal joint, forming a chela. Basal joints of maxillipeds stout, almost squarely truncated at the distal end, and furnished there with a short and strong claw whose tip shuts down into a groove between two rounded knobs.

Color, a uniform creamy-white.

Total length, 0.65 mm. Length of cephalothorax, 0.40 mm.

(*relata*, connecting or establishing a relation between several species, as the type of the new genus).

Remarks.—This new species was found in great abundance on the gills of a large barn-door skate, captured in about 60 fathoms of water. Although only 100 specimens were taken there were fully 1,000 on the single fish, the gills being literally covered with them. The present species differs from *longimana* in the details of the mouth parts, in the structure of the second antennae, and in the shape of the posterior appendages; from *longibrachia* it is sufficiently distinguished by the length of the second maxillae.

Genus BASANISTES Nordmann.

Generic characters of female.—Cephalothorax at right angles to the trunk axis, with no definite demarcation between the two; no dorsal carapace, abdomen, anal laminae, posterior processes, or genital process; a large spherical knob on the back of the head, a row of smaller knobs down the center of the back, and another row along either lateral margin. First antennae short, slender, and three-jointed; second pair stout and biramose, the exopod two-jointed, the endopod one-jointed, the latter considerably larger than the former and both armed with small spines. Mandibles slender and curved toward the tips where they are armed with fine saw teeth, all about the same size. First maxillae slender and tipped with three setae; second maxillae short and wrinkled, bulla large and club-shaped. Egg strings cylindrical and rather plump. Maxillipeds stout and standing well in front of the second maxillae, the terminal claw without accessory spines.

Male.—Unknown.

Type.—*Basanistes huchonis* (Schrank).

(*Basanistes*, *βησανιστής*, a torturer.)

Remarks.—Milne Edwards, missing entirely the generic characters in Nordmann's *Basanistes*, made of it a genus to take the place of Blainville's *Lernaeopoda*, and included in it the two species which Blainville had placed under *Lernaeopoda*. Since Blainville's genus was published 10 years before Nordmann's, if it were necessary to choose between the two, Blainville's name would take precedence. But both genera are valid, and so the names which Milne Edwards brought into this genus must be transferred back again.

TABLE OF SPECIES.

1. Terminal claw of maxillipeds longer than the second joint, the latter with a stout spine on its ventral surface........................... *coregoni* Neresheimer, 1909.
1. Terminal claw of maxillipeds longer than the second joint, the latter without spines or knobs.. *nordmanni* Kessler, 1868.
1. Terminal claw of maxillipeds shorter than the second joint, the latter with a large knob against which the claw shuts like a chela........ *huchonis* (Schrank), 1786.

Genus VANBENEDENIA Malm.

Generic characters of female.—Cephalothorax and trunk in the same straight line but separated by a well defined groove; the former short and much broader than long, without a dorsal carapace, the latter elongate, depressed, and indistinctly segmented; no posterior processes, genital process, abdomen, or anal laminae; first antennae short and unsegmented; second antennae uniramose; first maxillae bipartite, without palps; second maxillae straight and rigid, approximated for their entire length and fused at their tips, where they are joined to a mushroom bulla; egg strings filiform and much longer than the trunk.

Generic characters of male.—Cephalothorax and trunk in the same line and thoroughly fused, the separation being indicated, if at all, by a slight groove; no dorsal carapace; trunk shorter than the cephalothorax, conical, and bluntly rounded posteriorly, without any abdomen or anal laminae; antennae and mouth parts like those of the female; second maxillae and maxillipeds some distance behind the mouth tube (see pl. 28, fig. N).

Type.—*Vanbenedenia krøyeri*, the single species.

(*Vanbenedenia*, to P. J. van Beneden.)

TRACHELIASTINAE, new subfamily.

Subfamily characters of female.—Cephalothorax shorter than the second maxillae, much narrowed and flattened, in line with the trunk or bent a little backward; trunk elongate, flattened dorso-ventrally, enlarged posteriorly, with no traces of segmentation, no posterior processes, genital process, abdomen, or anal laminae; maxillipeds on the inner surface of the second maxillae, and the two removed a long distance behind the mouth tube; second maxillae united only at the tip, bulla mushroom shaped.

Male.—Unknown.

Remarks.—Since this subfamily includes but a single genus its characteristics for the present will be the same as those of the genus. The most marked character is the juxtaposition of the second maxillae and maxillipeds and their removal a long distance behind the mouth tube.

Genus TRACHELIASTES Nordmann.

Generic characters of female.—Cephalothorax separated from the trunk by a well-defined groove, and usually strongly curved; no dorsal carapace; first antennae indistinctly jointed; second antennae biramose, each ramus unsegmented and ending in a claw; first maxillae tripartite, without a palp; second maxillae long, stout, and wrinkled, united only at the tip to a mushroom-shaped bulla; maxillipeds small, with weak claws; egg strings large and about as long as the trunk.

Male.—Unknown.

Type.—*Tracheliastes polycolpus* Nordmann.

(*Tracheliastes*, *Τρᾱχηλιάω*, arching the neck like a horse.)

Remarks.—This genus, like the subfamily, may be recognized at once by the fact that the maxillipeds have migrated away from the other mouth-parts, along with the second maxillae, the two being found together some distance behind the mouth tube. Nordmann's figures and description were so convincing as to leave no question in regard to the validity of the genus. It has never been disputed, nor has it any synonyms like most of the other genera. Richiardi's species, *gigas*, was simply named with only a few words of description, but the size given, combined with these few words, makes it certain that he had a new species, and hence it has been included in the following table:

TABLE OF SPECIES.

1. Cephalothorax half the length of the second maxillae or more............... 2.
1. Cephalothorax less than one-fourth the length of the second maxillae......... 3.
2. Size small (7.5 mm.); cephalothorax and second maxillae conical; the latter, together with the trunk, covered with rusty spots; genital process present. *maculatus* Kollar, 1835.
2. Size small (6 mm.); cephalothorax and second maxillae cylindrical and much wrinkled; cephalothorax strongly arched; no genital process. *polycolpus* Nordmann, 1832.
2. Size large (35 mm.); cephalothorax flattened and curved forward but not wrinkled; no genital process........................*grandis*, new species, p. 645.
3. Size medium (12 mm.); cephalothorax short, cylindrical; second maxillae slender and tapering and not wrinkled; genital process present....*stellifer* Kollar, 1835.
3. Size large (30 mm.); mouth parts arranged like the sepals of a calyx; anterior third of second maxillae filiform...............................*gigas* Richiardi, 1880.

TRACHELIASTES GRANDIS, new species.

Plate 40, figs. 106 to 108.

Host and record of specimens.—Two females without egg strings and with no label to indicate their host or locality were found in the collection of the Museum. The better of the two has been numbered 43565, U.S.N.M., and is made the species type.

Specific characters of female.—Cephalothorax relatively very minute, curved forward ventrally between the second maxillae and much wrinkled; separated from the trunk by a deep invagination on either side and by a dorsal and ventral groove. Trunk massive, strongly flattened dorso-ventrally, gradually enlarged toward the center and then slightly contracted, the posterior margin almost squarely truncated, with a slight invagination at the center and rounded corners; no posterior processes, genital process, abdomen, or anal laminae. The convolutions of the oviducts form a series of slight rounded swellings along either side of the median line. These swellings increase in size posteriorly and are of a darker color that the rest of the trunk.

First antennae slender, cylindrical, slightly enlarged at the tips and obscurely segmented; second antennae with a short and stout basal portion made up of two segments, and two conical rami, each apparently unsegmented and ending in a short spine, the exopod nearly twice the length of the endopod. Second maxillae stout, strongly flattened dorso-ventrally, and tapering toward the tips, where they are joined to the slender pedicel of the mushroom bulla. The cephalothorax being curved forward ventrally, the bases of these second maxillae nearly meet on its dorsal surface, and they extend forward anteriorly in line with the body axis.

Maxillipeds large and swollen and inserted on the ventral surface of the bases of the second maxillae, some distance behind the mouth tube; they are made up of two stout conical joints and a strongly curved terminal claw.

Color (preserved material), a yellowish-white, the swellings of the oviducts a light brown, the bulla and its pedicel a dark cinnamon brown.

Total length, including the second maxillae, 38 mm. Length of cephalothorax, 5 mm.; of second maxillae, 10 mm.; of trunk, 32 mm. Width of cephalothorax, 5 mm.; of trunk, 12 mm. Thickness of the trunk, 7 mm.

(*grandis*, huge or immense, alluding to the trunk.)

Remarks.—If the immense size of the trunk and the details of the appendages did not make it certain that this was a new species, the meager material at the author's disposal would not warrant its establishment. Neither female possesses egg strings, the trunk of one is badly mutilated, and there are no data as to host or locality. And yet it will be evident to anyone that the specimens are certainly new and unique in many respects, and accordingly they are put forward as a new species, very much the largest of the genus.

BRIANELLINAE, new subfamily.

Subfamily characters of female.—Cephalothorax about the same length as the second maxillae, bent backward at a right angle with the body axis; trunk plump, with two posterior processes, but with no genital process, abdomen, or anal laminae; trunk unsegmented; maxillipeds minute and degenerate, removed a long distance behind the mouth-tube; second maxillae removed an equal distance behind the maxillipeds, fused throughout their entire length and armed at the tip with a bulla or with dichotomously branched horns, similar to those found in certain of the Lernaeidae; maxillary glands as external swellings on the trunk at the base of the second maxillae.

Male.—Unknown.

Remarks.—This subfamily just fills out the possibilities in the matter of the arrangement of the second maxillae and maxillipeds with reference to the mouth tube. In the Lernaeopodinae they are close together and close to the mouth-tube; in the Tracheliastinae they are close together, but are removed from the mouth tube; in the Clavellinae one of them is close to the mouth tube while the other is separated, and here in the Brianellinae they are both separated but at different distances. Such a completion affords gratifying proof that the original basis of systematization was well chosen.

BRIANELLA, new genus.

Generic characters of female.—Cephalothorax in line with the second maxillae and at right angles to the trunk axis, considerably longer than the trunk and about the same length as the second maxillae; separated from the trunk by a distinct groove; trunk pear-shaped, with posterior processes dorsal to the egg strings; first antennae rudimentary knobs; second antennae biramose and chelate at the tips; mouth area depressed or telescoped into the anterior surface of the head; second maxillae partially fused, each terminating in a dichotomously branched horn instead of a common bulla; maxillipeds reduced to papillae and terminating in small spines instead of claws.

Male.—Unknown.

Type.—*Brianella corniger*, new species.

(*Brianella*, to Dr. Alessandro Brian, who has published many valuable memoirs on the parasitic copepods.)

Remarks.—In addition to the separation of the second maxillae and maxillipeds from each other and from the other mouth-parts, this genus also offers a striking contrast to every other genus in the Lernaeopodidae in the absence of a bulla and the presence of dichotomously branched horns, similar to those found on the head of some of the Lernaeidae. And yet this is but little different from what we find in the genus *Charopinus*, where the second maxillae are entirely separate and end in enlarged disks, or fingerlike processes. It is but a short step from those processes to these horns, and the two are probably formed in a very similar manner. The removal of the maxillary glands to the cephalothorax is also similar to what is found in several genera of the Clavellinae. This genus, therefore, in its morphology as well as in the arrangement of the mouth parts, stands between the Lernaeopodinae and the Clavellinae.

BRIANELLA CORNIGER, new species.

Plate 41, figs. 109 to 113.

Host and record of specimens.—Two adult females with egg strings were obtained from the gills of a ray off the coast of Lota, Chile. The more perfect specimen is numbered 43573, U.S.N.M., and is made the type of the new species; the other specimen is numbered 43583 and becomes a paratype.

Specific characters of female.—Cephalothorax thick, cylindrical, longer than the trunk, and in line with the second maxillae at right angles to the trunk axis; head not enlarged and without a dorsal carapace; trunk ovoid, flattened dorso-ventrally, contracted anteriorly where it joins the cephalothorax, and smoothly rounded posteriorly; a single pair of posterior appendages dorsal to the egg strings, close together, parallel, and curved dorsally; no genital process, abdomen, or anal laminae; egg strings attached dorsally close to the processes, as long as the trunk and half as thick; eggs small, in 8 or 10 longitudinal rows, about 30 in a row.

First antennae very rudimentary, a mere unsegmented knob inside the second pair; second antennae indistinctly three-jointed and biramose at the tip, the two rami like the jaws of a pair of pincers, and each tipped with a minute spine; basal joint much enlarged, with a wide flattened and laminate process on the posterior margin. The area carrying the mouth tube is depressed or telescoped into the anterior part of the head, so that the mouth does not project beyond the surface. In this depression lie the first antennae and the first maxillae. The second maxillae are separate at their base and for one quarter of their length, then fused solidly. At the base of each maxilla, on the lateral margin where it joins the cephalothorax, is a maxillary gland, trapezoidal in outline, as wide as the maxilla, and projecting prominently. These glands are peculiarly large and their location is a conspicuous one. At the tips of these maxillae we do not find a bulla, but a pair of dichotomously branched horns. Each of these starts from the lateral margin of the maxilla on its own side, and the two extend away from each other; they are twice or thrice compounded and the branches are bluntly pointed. The maxillipeds are situated at the center of the space between the second maxillae and the mouth tube; their basal joints are minute, slender, and triangular in shape, while the terminal claws have degenerated into mere spines at the apex of the basal joints.

Color (preserved material), a dark yellowish-brown.

Length of cephalothorax, 5 mm.; of trunk, 4.75 mm.; of posterior processes, 4 mm.; of egg strings, 4.25 mm. Width of cephalothorax, 1.40 mm.; of trunk, 2.5 mm.

(*corniger*, carrying or wearing a horn, alluding to the second maxillae.)

Remarks.—This being the only species of the genus, it follows that it displays all the generic characters, and so becomes of great systematic interest. The remarks already made under the genus apply with equal force here.

THOMSONELLA, new genus.

Generic characters of female.—Cephalothorax half the length of the second maxillæ, the two in the same line and at right angles to the trunk axis; trunk pear-shaped and a little longer than the cephalothorax, indistinctly divided into four segments; two slender posterior processes dorsal to the egg strings; a rudimentary abdomen but no anal laminae; maxillipeds at the center of the space between the second maxillae and the mouth tube, small and rudimentary; second maxillae long and free to their tips where they are joined to an ordinary bulla. First antennae two-jointed, the basal joint the longer; second antennae biramose, exopod much larger than the endopod, both unsegmented; first maxillae tipped with three setae, and bearing a palp with two terminal setae.

Male.—Unknown.

Type.—*Thomsonella parkeri* (*Brachiella parkeri* Thomson).

(*Thomsonella,* to Prof. George M. Thomson, of the University of New Zealand, who first described the type-species.)

Remarks.—This new genus is established for the species described under the name *Brachiella parkeri* by Prof. Thomson in his "Parasitic Copepods of New Zealand,"[1] and afterward (1909) by Miss May E. Bainbridge,[2] who placed a question mark in front of the genus name. That it can not belong to the genus *Brachiella* is at once evident from the position and degeneration of the maxillipeds, as well as from the structure of the other mouth parts. It does not possess a single character assigned to the genus *Brachiella* except the large size and the separation of the second maxillae. It shows a close relationship to the new genus *Brianella* in the position and structure of the maxillipeds and in the general make-up of the entire body. But it differs from that genus in the structure of the first antennae, the mouth tube, and the second maxillae, and may be recognized simply by the presence of the bulla instead of the branched horns. It serves to place the new subfamily on a more secure foundation, and in the possession of a bulla it shows that the same variety exists in the new subfamily as in the older ones.

CLAVELLINAE, new subfamily.

Subfamily characters of female.—Cephalothorax much longer than the second maxillae and often bent backward until it rests against the dorsal surface of the trunk; usually narrow and wormlike; trunk flattened dorso-ventrally, with paired posterior processes, sometimes as many as six or eight, and often with an unpaired genital process; usually no abdomen and no anal laminae; maxillipeds close to the base of the mouth tube and looking like an under jaw in side view; second maxillae removed a long distance behind them, sometimes fused, sometimes separate, usually with a bulla; maxillary glands as external swellings at the base of these maxillae.

---

[1] Trans. New Zealand Institute, vol. 22, p. 374.

[2] Trans. Linnaean Society, ser. 2, Zool., vol., 11, p. 52.

Subfamily characters of male.—Cephalothorax fused with the trunk, with no traces of segmentation; no anal laminae or only very minute ones; second antennae biramose, but without a claw; in *Brachiella* and its relatives the cephalothorax and trunk are in the same line or the body is somewhat curved; in *Clavella* and its relatives the body is folded together ventrally with no distinction of cephalothorax and trunk.

Remarks.—This subfamily is considerably the largest of the four and includes all the more degenerate genera. Since it has also been the least well known and has served as a sort of wastebasket to catch such forms as could not readily be located elsewhere, more changes have been necessary and a much larger number of new genera have been introduced. The figures and the diagnoses given, however, will readily prove the validity of these genera, which are largely due to the differential characters of the males, here for the first time presented.

Genus THYSANOTE Krøyer.

Generic characters of female.—Cephalothorax in line with the trunk, short, thickset, flattened dorso-ventrally, and completely fused with the trunk or only imperfectly separated; trunk unsegmented, flattened like the cephalothorax, with no genital process, abdomen, or anal laminae; a pair of fingerlike posterior processes ventral to the egg strings; branched or unbranched fimbriate processes attached to the posterior margin of the second maxillae, to the body at the base of the second maxillae, and to the posterior corners of the trunk, sometimes hiding the egg strings. First antennae indistinctly segmented; second antennae biramose; first maxillae large, tripartite; second maxillae united only at their tips, bulla mushroom-shaped; maxillipeds large and powerful; egg strings usually short and stout.

Generic characters of male.—Cephalothorax in line with trunk axis, the two curved into a quarter moon and separated by a distinct groove; no dorsal carapace; trunk spindle-shaped, unsegmented, and terminated by two conical anal laminae, which are curved ventrally; mouth-tube and appendages at right angles to the body axis; second antennae uncinate; second maxillae and maxillipeds with stout sickle-shaped claws, one or both of them sometimes twisted like a corkscrew.

Type.—*Thysanote pomacanthi* Krøyer.

(*Thysanote*, *θύσανος*, a fringe, alluding to the fimbriate processes.)

Remarks.—This genus may be recognized at once by the fimbriate processes, whose dense fringe causes some of the species to bear a crude resemblance to a miniature human figure. The genus type shown by the male is fully as distinct as that of the female, and this has differentiated the genus so thoroughly that there has been almost no false identification of the species (see pl. 26, fig. G).

TABLE OF SPECIES.

1. Fimbriate processes few in number and well separated.......................... 2.
1. Fimbriate processes numerous and thickly massed............................. 3.
2. Processes unbranched, club-shaped..*appendiculata* (Steenstrup and Lütken), 1861.
2. Processes dichotomously branched..............*longimana* Wilson, 1913, p. 651.
3. Second maxillae with three single processes; a single bundle of unbranched processes on either side of the trunk at the posterior end....*fimbriata* (Heller), 1865.
3. Second maxillae with four bundles of processes; two similar bundles at the posterior end of the trunk, all dichotomously branched.............................. 4.
4. Posterior fimbriate processes recurved at the tips and entirely concealing the egg strings....................................*pomacanthi* Krøyer, 1863, p. 651.
4. Posterior processes straight, egg strings visible for half their length.
lobiventris (Heller), 1865.

THYSANOTE LONGIMANA Wilson.

Thysanote longimana WILSON, 1913, p. 257, pl. 47, figs. 262–264; pl. 48.

Host and record of specimens.—Five females and three males were obtained from the throat of the red snapper, *Neomaenis aya,* at Montego Bay, Jamaica, July 23, 1910, and both sexes are fully described in the reference given above. Since the host is found all along our Atlantic Coast as far north as Connecticut this parasite also may be classed as North American.

THYSANOTE POMACANTHI Krøyer.

Thysanote pomacanthi KRØYER, 1863, p. 288, pl. 15, fig. 1*a* to *i*.

Host and record of specimens.—Krøyer obtained 10 females from the gills of *Pomacanthus paru* in the Danish West Indies. M. T. Thompson recorded in his manuscript notes two females of this species from the gills of *Pomacanthus arcuatus* in the local collection at Woods Hole, Massachusetts. From the sketches and data accompanying this record it is certain that the specimens really belonged to this species, so that it may be recorded as North American. These specimens, however, can not be found, and hence no attempt is made to supplement Krøyer's description.

THYSANOTELLA, new genus.

Generic characters of female.—Cephalothorax curved forward and nearly as long as the trunk; the latter much the wider, with concave sides, each of the four corners prolonged into a single bundle of four filiform, unbranched processes; two pairs of posterior processes, one dorsal, the other ventral, close to the midline, with a tiny genital process between them. First antennae three-jointed; second antennae biramose, without claws; first maxillae bipartite, palp with a single spine; second maxillae fused, except for a short distance at the center, bulla disk-shaped; maxillipeds stout, terminal claw slender; egg strings club-shaped, and as long as the trunk.

Generic characters of male.—Cephalothorax ovoid, in line with the trunk and separated from the latter by a distinct groove; no dorsal carapace; trunk two-thirds the length and only one-fifth the diameter of the cephalothorax, distinctly divided into three segments and terminating in two lancinate plates.

First and second antennae close together at the upper and anterior corner of the cephalothorax, a considerable distance from the mouth tube; first antennae three-jointed; second pair uniramose and two-jointed; maxillipeds relatively enormous, the claw very powerful, bent so as to form three-quarters of a circle, and sharp pointed, with an accessory spine on the inner margin.

Type.—*Thysanotella multifimbriata* (Bassett-Smith).

(*Thysanotella*, the diminutive of *Thysanote*.)

Remarks.—This genus is established to include a single species described and figured by Bassett-Smith (1898, p. 96, pl. 6, fig. 2, *a* to *g*). Both sexes are known, and each differs so markedly from the types of the other genera that the validity of the genus is securely established, provided Bassett-Smith's description was correct. In the female the long and wormlike cephalothorax is like that found in *Eubrachiella*, *Clavella*, and *Charopinus*, but very different from that found in *Thysanote;* the fimbriate processes are all on the trunk, and there are two pairs of posterior processes. The entire make-up of the male is peculiar; the body is reduced to less than a quarter the size of the cephalothorax, but is distinctly segmented; the two pairs of antennae are away up on the back of the cephalothorax, and the maxillipeds are enormously developed and peculiar in position. Bassett-Smith himself says of this male: "It shows distinctly the *Brachiella* form." But from the figure here given (fig. H, pl. 26) it will be seen that it conforms far more to *Charopinus* than to *Brachiella*. He tells us that he only succeeded in making a rough drawing of this male and that he lost the specimen while preparing it for mounting. But granting this, no amount of correcting or finishing could ever cause his figure of the male to bear any resemblance to that of *Brachiella* or *Thysanote*.

Genus CHAROPINUS Krøyer.

Generic characters of female.—Cephalothorax elongate, cylindrical, more or less distinctly separated from the trunk, sometimes turned back at right angles or even against the dorsal surface of the trunk; usually no dorsal carapace; trunk pear-shaped, enlarged and often flattened posteriorly, and carrying there a pair of filiform posterior processes, dorsal to the egg strings; no genital process, abdomen or anal laminae. First antennae indistinctly four-jointed; second antennae with a curved exopod and a jointed endopod, making the rami somewhat chelate; first maxillae tripartite, palp with one or two minute spines; second maxillae long and usually quite corrugated, sometimes joined at their tips and furnished with a bulla, sometimes separate, with their ends enlarged in various patterns and clasping a chitin bar; maxillipeds with a short terminal claw, shutting against a projection on the second joint.

Generic characters of male.—Anterior portion of cephalothorax at right angles to the posterior portion and the trunk; no distinct dorsal carapace; thorax segmented with an enlarged genital segment; a well-defined and segmented abdomen, carrying anal laminae. First antennae indistinctly four-jointed; second antennae biramose, rami usually curved and chelate; first maxilla tripartite, palp with two setae; second maxillae and maxillipeds some distance behind the other mouth parts and close together.

Type.—*Charopinus dalmanni* (Retzius).

(*Charopinus*, the name of a parasite in Martial.)

Remarks.—Krøyer's description of the species (*dalmanni*) which he made the genus type, and of a new species *ramosus*, and the details given in his figures, leave no doubt that the "new" genus and species, *Stylophorus hippocephalus*, proposed by Hesse in 1878, is really only a new species of *Charopinus*. To these three species Scott added a fourth, *dubius*, in 1900, but if one will examine the figures and description in the same paper (1900, p. 173) of the species which Scott named *Lernaeopoda cluthae*, it will be evident that this also belongs to the present genus and not to *Lernaeopoda*. This genus is the only one in the entire family in which the adult male is completely segmented, while the male of *Lernaeopoda* shows no segmentation whatever. In particular the partial or complete separation of the two segments bearing the second maxillæ and maxillipeds is characteristic of the male *Charopinus*, and this is admirably shown in Scott's figure. His species, therefore, must be removed from the genus *Lernaeopoda* and placed here with the other species of *Charopinus*. Exactly the same statements apply to the species called *Brachiella malleus* by Nordmann (1832, p. 95) and Vogt (1877, p. 46), and also to the species named below (*dentatus*), in each of which the male proves beyond a doubt that the species belongs to the genus *Charopinus*. It will be noted also that every species of the genus as here constituted is parasitic upon the gills or in the nasal openings of a ray.

TABLE OF SPECIES.

1. Tips of second maxillae completely fused and furnished with a bulla for attachment to their host.......................... 2.

1. Second maxillae entirely separate or slightly coalesced, the tip of each enlarged and anchored separately in the host.......................... 3.

2. Second maxillae half as long again as the trunk; bulla thin and wide. *dubius* (T. Scott), 1900.
2. Second maxillae the same length as the trunk; bulla thick and narrow. *cluthae* (T. Scott), 1900.
2. Second maxillae half the length of the trunk; bulla thin and narrow. *malleus* (Rudolphi), 1832, p. 654.
2. Second maxillae one-third the length of the trunk; bulla small and mushroom shaped; no posterior processes.................. *dentatus* (Wilson), 1912, p. 654.
3. Ends of second maxillae slightly coalesced, branched separately; posterior processes short, curved.. *ramosus* Krøyer, 1863.
3. Ends of second maxillae enlarged into semilunar disks; posterior processes strongly curved.................................... *dalmanni* (Retzius), 1829, p. 655.
3. Ends of second maxillae terminating in finger-like projections; posterior processes short and divergent.............................. *hippocephalus* (Hesse), 1879.
3. Ends of second maxillae enlarged into semielliptical disks, which are slightly coalesced at the center; no branches or projection; posterior processes short and straight.................................. *bicaudatus* (Krøyer), 1837, p. 656.

CHAROPINUS MALLEUS (Rudolphi).

Brachiella malleus NORDMANN, 1832, p. 95.—VOGT, 1877, p. 46, pl. 3, figs. 1–8.

Host and record of specimens.—A single lot of females with egg strings broken was taken at Port Arthur, Manchuria, by J. F. Abbott, and were sent to the author from Stanford University by Dr. C. H. Gilbert; there is no record of the host or date of capture. These parasites have been given Cat. No. 38578, U.S.N.M.

Remarks.—This species was first described in manuscript notices by Rudolphi in 1817 under the name *Dirhynchus malleus.* These notices were handed over to Nordmann, who published the species in 1832 as *Brachiella malleus*, with a short description but no figure. In 1877 Vogt published a more elaborate description, accompanied by excellent figures, and it has been noted by many subsequent investigators. The type of male however, which is admirably portrayed by Vogt, is very different from that belonging to the genus *Brachiella*, but is like *Charopinus*, and accordingly is transferred to this latter genus.

CHAROPINUS DENTATUS (Wilson).

Brachiella dentata WILSON, 1912, p. 97, pl.9.

Host and record of specimens.—Six lots of this species, numbering twenty to twenty-five specimens each, and including both sexes, were obtained by Rev. George W. Taylor, former director of the Pacific Coast Biological Station at Nanaimo, British Columbia. They were taken from the gill arches in the throat of the large skate, *Raja binoculata*, and the lots have received, respectively, Cat. Nos. 38636, 38642, 38643, 38644, 39537, and 39540, U.S.N.M.; the first lot were made the types of the species.

Remarks.—Both sexes of this species were fully described and figured in the paper referred to above, and at the time the manuscript was written they were referred to the genus *Brachiella* in consequence of the structure of the second maxillae. A more careful study of both sexes and especially of the male, in the light of the differentiations here established, shows that the species belongs to the genus *Charopinus* and not to *Brachiella*, and it is here transferred, with the necessary change in the adjective (see pl. 26, fig. I).

This and the two following species are the only ones thus far found in North American waters.

CHAROPINUS DALMANNI (Retzius).

Lernaea dalmanni RETZIUS, 1829, p. 109, pl. 6.
Lernaeopoda dalmanni KRØYER, 1837, p. 264, pl. 2, fig. 11; pl. 3, figs. 4*a* and 4*b*.
Charopinus dalmanni KRØYER, 1863, p. 280, pl. 14, fig. 6, *a* to *g*.—T. SCOTT, 1900, p. 169, pl. 8, figs. 6 to 10.

Host and record of specimens.—Two females with egg strings were obtained from the nostrils of a skate at Polperro in 1884, and were sent to the United States National Museum by Rev. A. M. Norman, of England. They were numbered 12909, U.S.N.M. Another lot of three females with egg strings was obtained from the nostrils of the barndoor skate, *Raja levis*, at South Harpswell, Maine, July, 1913, by the author. These have received Cat. No. 43575, U.S.N.M.

Remarks.—The description and figures published by Retzius, although in many respects imperfect, leave no doubt as to the identity of the parasite. And when supplemented by the excellent work of Krøyer and T. Scott there is practically nothing to be added except a few comments upon the morphology, and one or two corrections. Turner and Wilson published, in 1862, an extended account of the present species, including observations on its larval form. Their figures are admirable, but whatever value their description may possess is greatly diminished by the fact that they mistook the ventral for the dorsal surface, and have not named correctly a single appendage except the second antennae, whose nomenclature they borrowed from Krøyer. The "eyelike" spots noted by Retzius and Krøyer on either side of the thorax in front of the base of the second maxillae are doubtless the maxillary glands, which often appear in other genera of this family in the form of protuberances upon the external surface of the cephalothorax. During the migration forward of the maxillipeds and the migration backward of the second maxillae, these glands are sometimes drawn out of the maxillae into the body of the cephalothorax. Turner and Wilson describe what is evidently the body of the gland and the excretory duct leading from it. The posterior appendages are said by every investigator who has described the species to spring from the ventral surface of the body in front of the egg strings. But they are just as certainly dorsal as in *ramosus* and the other species of the genus. If the cephalothorax be straightened up into line with the rest of the body, the mouth parts are of course on the ventral surface, and the posterior appendages are just as surely dorsal. The discovery of this species in the nostrils of the barndoor skate upon our own coast makes it necessary to include it in the North American fauna.

CHAROPINUS BICAUDATUS (Krøyer).

Plate 41, figs. 114 to 118; plate 42, figs. 119 and 120.

Lernaeopoda bicaudata Krøyer, 1837, p. 275, pl. 3, fig. 11.

Brachiella pastinacae P. J. van Beneden, 1851, p. 118, pl. 4, figs. 8, 9.—Kurz, 1877, p. 389, pl. 25, figs. 2, 3.

Brachiella pastinaca Bainbridge, 1909, p. 50, pl. 8, figs. 6, 7; pl. 9, fig. 8.—T. and A. Scott, 1913, p. 211, pl. 64, fig. 8.

Host and record of specimens.—Eight females with egg strings were obtained from the spiracles of the common dogfish, *Squalus acanthias*, by Dr. F. D. Lambert at South Harpswell, Maine, July, 1912. They have received Cat. No. 43536, U.S.N.M.

Specific characters of female.—Cephalothorax short and wide, and inclined at an angle of 45° to the trunk axis; a narrow dorsal carapace divided longitudinally through the center, the two halves resembling closely the elytra of beetles, and diagonally truncated anteriorly; trunk somewhat pear-shaped, narrowed into a long and slender neck anteriorly, swollen into a sphere posteriorly, and flattened dorso-ventrally; posterior processes cylindrical, plump, dorsal to the egg strings and half the length of the latter, and inclined backward; egg strings stout, cylindrical, and about the same length as the trunk; eggs in 8 longitudinal rows, about 18 eggs in the longest row.

First antennae two-jointed, the basal joint considerably swollen and armed on the anterior margin with a long and stout spine, the terminal joint narrower and tipped with two olfactory cylinders and a small spine; second antennae biramose, both rami unsegmented, the endopod considerably larger than the exopod, and both of them covered with small spines and bristles. Mandibles long and narrow, with four large principal teeth, two smaller secondary teeth, and two intermediary teeth. First maxillae tripartite, the outer ramus smaller than the other two, palp large and tipped with two setae. Second maxillae slender and cylindrical, two-fifths as long as the trunk and enlarged at the tip into a crescent or semicircle, at right angles to the axis of the maxilla. Maxillipeds with a stout basal joint, armed on the inner margin with two knobs covered with spines and a large solitary jointed spine; terminal claw slender, with an accessory claw at the tip on the inner margin.

Color (preserved material), a uniform yellowish white.

Cephalothorax, 2.20 mm. long, 1.25 mm. wide. Trunk, 3.75 mm. long, 2 mm. wide, 1.60 mm. thick. Egg strings, 2.75 mm. long. Posterior processes, 1.10 mm. long.

(*bicaudatus*, *bis*, two, and *caudatus*, tailed, alluding to the pair of small posterior processes, looking like two tails.)

Remarks.—This is the only parasite within the author's knowledge that has ever been found upon the common dogfish along our North American coasts. Doctor Lambert has handled thousands of dogfish specimens for laboratory purposes, and this is the only instance in which any copepods have been found upon them. The species, therefore, can not be at all common; it may be readily distinguished by the divided carapace, the slender neck, usually flexed backward, and the plump posterior processes.

This species was discovered by Krøyer in 1837 and was referred to the genus *Lernaeopoda,* but he placed a question mark after the genus name and said in the context: "There is some doubt as to whether this Lernaean should be referred to the genus *Brachiella* or *Lernaeopoda,* or whether it should be made the type of a new genus." The species was afterwards described by Beneden under the name *Brachiella pastinacae*; it has since been noted by Kurz (1877), Brian (1906), Bainbridge (1909), and T. and A. Scott (1913), besides appearing in several lists. In some of these the specific name ended in a vowel, in others in a diphthong; it ended originally in a diphthong. That it really belongs in the genus *Charopinus* is clearly shown by the backward flexion of the cephalothorax, by the enlarged ends of the second maxillae, and by the structure of the first antennae and first maxillae. The description and figures given by Miss Bainbridge[1] (1909) are the best that have been thus far published; the following differences are noted in the present specimens. The first antennae have only two joints instead of four, and are exactly like those figured by Miss Bainbridge (pl. 9, fig. 8). The teeth on the mandibles correspond with those given by Miss Bainbridge, and are a trifle different from the ones figured by Kurz. There are no traces of the "pair of slender clawed appendages" at the sides of the mouth tube noted by Miss Bainbridge. It would be very difficult to understand what these would represent, if present. That they can not be "maxillary palps," as suggested by Thomson for his *Brachiella parkeri* and quoted by Miss Bainbridge, is at once evident when we reflect that the maxillae already have well-developed palps. In examining a British specimen of *Brachiella parkeri* Miss Bainbridge failed to find the structures designated "maxillary palps" by Thomson, and in the specimens here described the present author fails to find the structures noted by Miss Bainbridge. It seems probable in both cases, therefore, that they were accidental rather than specific.

Genus NAOBRANCHIA Hesse.

Generic characters of female.—Cephalothorax narrow and elongate and well separated from the trunk; a minute but distinct dorsal carapace on the head; trunk broad and well rounded anteriorly, much narrowed posteriorly, with a pair of ventral posterior processes; abdomen well differentiated and carrying anal laminae; egg strings extending in front of the oviduct as well as behind it, and inclosed in a membrane, strengthened by ribs.

---

[1] Miss May E. Bainbridge, now the Hon. Mrs. Henn Collins.

First antennae three-jointed; second antennae biramose, the exopod two-jointed, the endopod simple; first maxillae bipartite, without a palp; second maxillae in the form of bands, containing longitudinal muscles, which clasp around the gill filaments of the host; no bulla; maxillipeds of the usual pattern; a pair of spoon-shaped palps attached either to the second joint of the maxillipeds, or to the ventral surface of the head.

Generic characters of male.—Cephalothorax and anterior trunk in the same line and indistinguishably fused, without any trace of segmentation, the two covered with a dorsal carapace; posterior trunk turned ventrally at right angles to the anterior portion, and projecting from beneath the posterior end of the carapace as a large process behind the second maxillae; anal laminae small, sometimes entirely lacking. First antennae three-jointed; second antennae biramose, the exopod jointed and chelate, the endopod simple; first maxillae bipartite, without a palp; second maxillae and maxillipeds removed some distance behind the other mouth parts, about the same size and armed with stout claws.

Type.—*Naobranchia cygniformis* Hesse.

(*Naobranchia*, *ναίω*, inhabiting and *βράγχια*, gills.)

Remarks.—This genus is one of the most interesting in the entire family. The female can be recognized at once by the flattened muscle bands which serve for second maxillae, and by the fact that the egg strings are carried inside of a protecting membrane. The anterior part of the body of the male is similar to that of *Thysanote*, but the posterior body is bent sharply at a right angle and projects ventrally like an unpaired appendage behind the second maxillae. These characters will distinguish either sex at a glance, and since they are so totally different from all other genera it follows that an account of the internal as well as the external morphology of the genus ought to be interesting as well as instructive. From serial sections of *Naobranchia lizae* we learn that the mouth tube, as in most other genera, is the most anterior portion of the body. Through it runs the thread-like esophagus (*oe*, fig. 121), which is bent more sharply than in *Achtheres* and *Clavella*, and which extends a considerable distance behind the maxillipeds. It enters the stomach at the center of the anterior end, the entrance being surrounded by a rather weak sphincter muscle. The anterior portion of the stomach (*s*) is thrown into a series of fairly regular transverse folds by alternate constrictions and enlargements. When it reaches the bases of the second maxillae these folds abruptly cease without any change in the average diameter. This smooth posterior portion of the stomach passes insensibly into the intestine (*i*) which is curved a trifle upward nearer to the dorsal surface of the body and opens at the anus (*a*). The cells of the glandular layer of the stomach and intestine are similar to those of other genera (figs. 123, 126, 133). The frontal gland (*fg*, fig. 122) is at the extreme anterior portion of the head and is proportionally very small. This genus is not permanently fastened to its host by any bulla or frontal filament, and hence a much smaller gland is sufficient. The second maxillae are flattened into a thin ribbon and the maxillipeds are extremely minute. Hence, there are no excretory glands in either of them, but there is a pair of large glands in what may be called the shoulders of the trunk, opposite the bases of the second maxillae and above the tips of the egg strings (fig. 125). The infra- and supra-esophageal ganglia are exceptionally large, and there is not the disparity in size between them that was noted in *Achtheres* (*ig*, *sg*, fig. 122).

Each ganglion shows the usual nerve connections with the various appendages, but the large posterior nerve (*p*), which runs back along the floor of the neck and trunk, is given off from the ventral surface of the infra-esophageal ganglion and not from its posterior end. The cement glands are in the posterior part of the body on either side of the intestine. The ovary and uterine processes of the oviducts are arranged similarly to those of *Achtheres*. On examining cross sections of the second maxillae it is found that in the process of becoming flattened they have also undergone other changes. On the outer surface of the maxilla there is a thin layer of ordinary skin (*s*, fig. 124); immediately beneath this are the three bundles of muscles (*m*) symmetrically arranged, one at the center and one at a little distance toward each lateral margin. Each muscle runs along its own cylindrical tube and is distinct from the others, but the tubes are connected across the two intervals by open spaces (*o*) in which may be found a thin muscular ribbon. That portion of the maxilla on the inner side of the muscles is much thicker than the outer skin and has become solidified into a homogeneous mass in which there is no longer any distinction of dermis, epidermis, and subcutaneous tissue (*n*, fig. 121). This mass has every appearance of cartilage and takes a cartilage stain. On the contrary, the blunt claws at the tips of the maxillae take the eosin, but do not take the haematoxylin.

TABLE OF SPECIES.

1. Egg strings reaching forward nearly to the base of the second maxillae; abdomen reaching backward nearly to the tips of the egg strings. . *lizae* (Krøyer), 1863, p. 660.
1. A long interval between the second maxillae and the egg strings; abdomen scarcely reaching the center of the latter.. 2.
2. Cephalothorax much longer than the rest of the body and filiform. *cygniformis* Hesse, 1863.

2. Cephalothorax the same length as the rest of the body, thick and stocky....... 3.
3. Egg strings longer than the trunk and parallel...........*amplectens* (Kurz), 1877.
3. Egg strings much shorter than the trunk and inclined toward each other.
occidentalis, new species, p. 663.

NAOBRANCHIA LIZAE (Krøyer).

Plate 27, fig. J; plate 42, figs. 121 to 124; plate 43, figs. 125 to 132; plate 44, figs. 133 to 135.

Anchorella lizae Krøyer, 1863, p. 29, pl. 16, fig. 11 *a* to *c*.

Host and record of specimens.—Four adult and two young females and two males were obtained by Dr. Edwin Linton from the gills of the common mullet, *Mugil cephalus*, at Beaufort, North Carolina, July 10, 1901. They are numbered 39611, U.S.N.M. Doctor Linton states that other specimens were found later the same year, and still others during the following years, so that it is fairly common on the mullet.

Specific characters of female.—Cephalothorax cylindrical, longer than the trunk and tapering gradually and uniformly; head exceptionally small, neither enlarged nor separated from the neck and covered with a minute dorsal carapace; neck slender and separated from the trunk by a well defined dorsal groove and ridge; trunk rectangular, with rounded corners, three-fifths as wide as long, and strongly flattened dorso-ventrally; anterior portion of the trunk making up the full width, posterior portion much narrowed, with the rectangle filled out along the lateral margins by the egg strings. In young females the genital segment is well differentiated, somewhat enlarged, with strongly convex sides, which are prolonged into a pair of stout conical posterior processes on a level with the ventral surface. To each of these processes is attached one end of the rib, which supports the membrane covering the egg string on that side. Inside of these processes there is a short and narrow one-jointed abdomen, to the posterior margin of which is attached a pair of minute conical anal laminae. In the adult female this abdomen is practically absorbed into the genital segment, the only indication of it being the anal laminae. The egg strings are peculiar in being turned forward along the lateral margins of the trunk and backward a little beyond the tips of the posterior processes. They are club-shaped, largest near the posterior ends and tapering rapidly anteriorly. They are a little more dorsal than ventral, especially at the posterior ends. They are covered and held securely in place by a transparent membrane, strengthened by a rib which runs along the center of the outer surface (fig. 127), turns dorsally at the posterior end, runs forward a little ways, and then turns inward to the dorsal surface of the trunk (fig. 132). The eggs are rather large and not arranged in rows, from 150 to 175 in each egg string. The two egg strings touch dorsally at their widened posterior ends, but are separated ventrally by the enlarged genital segment.

First antennae short, slender, conical, the basal joint much enlarged, the two terminal joints narrowed; second antennae biramose and turned down squarely across the frontal margin, both rami one-jointed, the endopod (dorsal) half as long again as the exopod and bluntly rounded, the exopod with two short spines at the tip and a short, one-jointed process on the ventral surface. The mouth-tube is broadly conical and extends beyond the tips of the second antennae. The first maxillae are short, stout, bipartite, and destitute of a palp. The second maxillae are comparatively long and wide. Each is flattened into a broad band of cartilaginous substance, manipulated by three longitudinal muscles. These bands pass entirely around the gill filament, and thus hold the parasite securely in place. The nature of these second maxillae has puzzled all the observers who have thus far described any species of this genus. Does each of the ribbonlike bands represent a separate maxilla? Or does the right half of both bands represent the right maxilla and the left half the left maxilla? If the former, does each maxilla extend around the filament from its own side, or do they both start from the same side? If the latter, how are the bands joined where they meet? In adult specimens these maxillae are so completely fastened that one can get no idea of the way in which they are formed.

Fortunately, one of the specimens obtained at Beaufort was a young female in which the second maxillae were not yet fully developed, and this specimen (fig. 128) answers our questions for us. Each band represents a separate maxilla, and the two are anterior and posterior instead of right and left. Furthermore, both bands started on the midline of the ventral surface of the cephalothorax and extended around the filament from the left to the right side of the parasite. Here on the right side and sunk into the surface of the cephalothorax are two sockets, into which the blunt claws on the tips of the maxillae fit. The claws and the sockets are gradually fused together, until in the adult they can no longer be separated. Each maxillae, therefore, corresponds to an ordinary maxilla flattened laterally. As these maxillae migrated toward the ventral midline the base of one moved a little forward and the base of the other a little backward, so bringing the two into line. From the arrangement of the claw on the tip of each maxilla it would seem as if there was no orientation during this migration. After the migration the maxillae extended around the filament, with the inner surface of the left hand one and the outer surface of the right hand one next to the filament.

Maxillipeds with a short, triangular basal joint and a slender, curved, terminal claw, armed with a blunt spine on its inner margin near the center. Outside of and a little behind the maxillipeds, on the lateral margins of the head, are located the peculiar appendages noted by both Hesse and Kurz, but apparently overlooked by Krøyer in the present species. Each is ovate in outline, thin, convex outwardly and concave inwardly, and is attached by a narrow neck to the lateral margin of the head just behind the carapace. In the present species they are relatively so small and they lie so close to the surface of the head that they are easily overlooked (see p. 664).

Color, a uniform white; eggs strings a faint pink or flesh color; alimentary canal a deep black, most conspicuous in the neck, where it appears as a broad black band with undulating margins; second maxillae yellowish (Doctor Linton's manuscript notes).

Total length, 8.4 mm. Length of cephalothorax, 3.4 mm.; of egg strings, 2.25 mm.; of trunk, 3 mm.; of second maxillae, 2.5 mm.

Width of cephalothorax, 0.5 mm.; of trunk, 1.85 mm.; of second maxillae, 0.9 mm.

Specific characters of male.—General form ovate, the head at the pointed end; cephalothorax and anterior trunk in the same line and covered with a dorsal carapace; posterior trunk at right angles to the rest of the body. First antennae slender and indistinctly three-jointed; second antennae biramose, the two rami about the same length, the endopod one-jointed and bluntly rounded, the exopod two-jointed and tipped with a short curved claw; mouth tube broadly conical and pointed ventrally, much longer than the antennae; first maxillae bipartite and without a palp, attached to the side of the mouth tube at about its center, with the tips of the setae projecting a little beyond the end; second maxillae and maxillipeds almost exactly alike, relatively large, with massive basal joints and short curved terminal claws; behind the second maxillae projects ventrally a broad conical genital process, somewhat corrugated at its tip.

Color, a light yellow.

Total length, 0.26 mm. Greatest diameter, 0.13 mm.

(*lizae*, from Krøyer's specific name (*Mugil liza*) of the host.)

Remarks.—One specimen of this species was obtained by Krøyer from the gills of "*Mugil liza*" (*M. curema*) near New Orleans, Louisiana, and was described and figured in his Bidrag till Kundskab om Snyltekrebsene. The specimen was a young female, 3 mm. in length and without egg strings, and he referred it to the genus *Anchorella*. But he added that if his view of the structure of the attachment apparatus was correct the species might properly be considered the type of a new genus. In the same year (1863) Hesse published[1] the description and figures of a new genus and species which he named *Naobranchia cygniformis.* Krøyer's specimen undoubtedly belonged to this same genus, and hence must be called *Naobranchia lizae.* In 1877 Kurz in his Studien der Lernaeopodiden[1] described a new genus and species which he designated *Cestopoda amplectens.* He was thoroughly familiar with Krøyer's paper and made several quotations from it, and concluded that his specimens and Krøyer's "certainly belong, if not to the same species, at least to the same genus." He added that the data with reference to Krøyer's species, which are necessary to enable us to tell whether the two are identical, are lacking. If he could have had the data here presented he would have seen at once that the two species are distinct. However, he seems to have entirely overlooked Hesse's paper, and since Hesse's species is a third one belonging to the same genus, the name which he gave to that genus must stand, and "*Cestopoda,*" given by Kurz, becomes a synonym. The distinctive characteristics of the present species are the comparatively great width of the second maxillae, the elongation of the trunk, and the form and position of the egg strings. In the other species some of the eggs are carried in front of the opening of the oviduct, but the great majority are behind it, and the egg strings taper posteriorly; here only a few of the eggs are carried behind the opening, while the great majority are in front of it, and the egg strings taper anteriorly. The male also, which is here described for the first time, serves to distinguish the species. The large and prominent genital process is especially noteworthy, as well as the similarity in size and structure between the second maxillae and the maxillipeds.

---

[1] Ann. des Sci. Nat. (4), Zool., vol. 20, pp. 122 to 132, pl. 1, fig. 1, *a-f*.

NAOBRANCHIA OCCIDENTALIS, new species.

Plate 44, figs. 136 to 139.

Host and record of specimens.—Five adult females and one male were obtained from the gills of the Pacific cod, *Gadus macrocephalus,* at Chignik Bay, Alaska, August 7, 1903, by the Bureau of Fisheries steamer *Albatross* during the Alaska salmon investigations. The best female has been selected as the type and numbered 43579, U.S.N.M. The remaining specimens with the male become paratypes and have been numbered 39567, U.S.N.M.

Specific characters of female.—Cephalothorax about the same length as the trunk, much enlarged and wrinkled at the base, tapering toward the head, where it is considerably smoother; head not enlarged, but covered with a minute and smooth dorsal carapace; neck distinctly separated from the trunk by a deep dorsal groove and shallower ones on the sides; trunk triangular, much flattened dorso-ventrally, the posterior corners of the triangle projecting over the egg strings; posterior margin inclined on either side toward the genital segment; the latter clearly differentiated in young females, but in older adults absorbed into the trunk.

---

[1] Zeit. fur wiss. Zool., vol. 29, p. 407.

First antennae indistinctly three-jointed, the basal joint enlarged; second antennae with a two-jointed exopod and a one-jointed endopod, the latter much longer than the former.

Mouth tube a broad cone, overlapping the tips of the second antennae; first maxillae bipartite and rather stout, without a palp. Second maxillae narrow, but each maxilla with three longitudinal muscles, as in the preceding species. Maxillipeds with a broad triangular basal joint and a short terminal claw. Just behind the base of each maxilliped is a spoon-shaped appendage as large as the entire head and attached to the ventral surface of the head by a narrow base. In nearly all the preserved specimens these appendages project from the head like a pair of enormous ears, but in one specimen they are turned forward and laid down over the mouth parts as though to protect them. Kurz says that in the live animal they project hardly at all. He calls them sucking disks and says that they have the same form and structure as the lunules in *Caligus*. He does not show such a structure, however, in the figure given, and certainly in the present and the preceding species they have nothing resembling that structure (see p. 662). When inflated and standing out sidewise, they cause the head to look something like a pawnbroker's three-ball sign.

Color (preserved material), yellowish-white.

Total length (without egg strings), 8 mm. Length of cephalothorax, 4 mm.; of trunk, 4 mm.; of egg strings, 3.6 mm. Width of cephalothorax at base, 1.65 mm.; of trunk, 2.8 mm.; of egg strings, 1.65 mm.; of second maxillae, 0.5 mm.

Specific characters of male.—General form ovoid, head at the pointed end; cephalothorax and anterior trunk covered with a carapace, posterior trunk turned at right angles and terminating in a pair of anal laminae. First antennae indistinctly jointed; second antennae biramose and no longer than the first pair, endopod bluntly rounded, exopod two-jointed and ending in a minute chela; first maxillae bipartite and without a palp; second maxillae longer than the maxillipeds and projecting well from the ventral surface, with a slender terminal claw; genital process wide and long, its sides roughened by many ridges and grooves.

Color, a grayish-white.

Total length, 0.66 mm. Greatest width, 0.33 mm.

(*occidentalis*, western, being the first species from the Pacific coast of North America.)

Remarks.—The facts brought out in the description of these two species enable us to supplement and correct the interpretations of Krøyer, Hesse, and Kurz in the following particulars:

The head is covered by a minute, but distinct, dorsal carapace. The second antennae are biramose, the exopod two-jointed, the endopod one-jointed. The first maxillae are bipartite and have no palp. The egg strings are attached, not at the proximal ends, but on one side, and to the trunk (genital segment) in front of the abdomen. The covering of the egg strings is a thin membrane, which is probably elastic, but is not "muscular."

The strange structures outside of and behind the maxillipeds seem at first sight anomalous, but Hesse describes and figures them in *cygniformis* as occurring on the second joint of the maxillipeds.

In comparison with the other species it is doubtful whether they actually do occur on the maxillipeds; but however that may be, they are certainly closely connected with those organs and may possibly represent palps. They do not show the structure of sucking disks, as most of the authors would have us believe, either in surface view or in sections, and it is extremely doubtful if they ever function in that manner. The modified second maxillae are universally designated as "muscle bands," but when examined in sections they are found to be epithelial and cartilaginous rather than muscular. The muscles are in the form of three bundles of fibers running lengthwise of the bands, which probably represent the ordinary longitudinal muscles of the second maxillae. How this attachment apparatus is formed in the copepodid larva and how it is thrown around the gill filament of the host can not be determined until we obtain the development history of the larva.

Genus CAULOXENUS Cope.

Generic characters of female.—Cephalothorax stout, separated from the trunk by a deep constriction, like the waist of a wasp; trunk a stout, sacklike, unsegmented ovoid; no posterior processes, genital process, abdomen, or anal laminae; egg strings ovoid, shorter than the trunk; second maxillae elongate, fused through their entire length, tapering toward the distal end, where they are furnished with a broad, disklike bulla; these maxillae are attached at about the center of the cephalothorax and are folded back against the head. Male, unknown.

Type.—*Cauloxenus stygius* Cope.

(*Cauloxenus*, *καυλὸς*, a stem, and *ξενὸς*, a guest.)

Remarks.—This genus contains but a single species which is parasitic on the blind fish, *Ambylopsis spelaeus* De Kay. Both the host and the parasite were obtained by Professor Cope from Wyandotte Cave. The parasite was fastened to the inner edge of the upper lip of the fish, where it had to hold its body rigidly, by means of its powerful second maxillae, at an angle with the fish's lip in order to keep itself from being eaten. Professor Cope has given in the American

Naturalist (July, 1872, page 411), an account of the species followed by a diagnosis and accompanied by three text figures. The generic characters just given have been taken largely from his diagnosis, and, of course, apply equally well to the species. Neither his description nor his figures give us any details of the appendages, and since the original specimens have been lost we are left with the above meager details. They appear sufficient, however, to guarantee the validity of the genus, and so it is retained with the hope that sometime other specimens may be obtained and the genus be more firmly established.

Genus CLAVELLA Oken.

Clavella Oken, 1815.
Schisturus (part) Oken, 1815.
Lernaeomyzon Blainville, 1822.
Clavella Cuvier, 1830.
Anchorella Nordmann, 1832.—Krøyer, 1837. Not *Anchorella* Cuvier, 1830.

Generic characters of female.—Cephalothorax distinctly separated from the trunk, long, wormlike, and standing at an angle with the body axis, often in line with the second maxillae; trunk pear-shaped or ovoid, without posterior processes, abdomen, or anal laminae; an unpaired genital process often present, ventral to the anus and connecting with the semen receptacle.

First antennae three-jointed, arising from the ventral surface of the head between the second antennae and the proboscis; second antennae uniramose, turned inward toward each other across the frontal margin of the head, often meeting or even overlapping on the midline; first maxillae bipartite, with a palp; second maxillae entirely fused, usually very short, sometimes altogether lacking; maxillipeds stout, the terminal claw usually with an accessory claw on its inner margin.

Generic characters of male.—Cephalothorax and trunk folded together ventrally and fused into an unsegmented ovoid, in which there is no distinction of parts; no dorsal carapace or anal laminae; first antennae two-jointed; second antennae uniramose and three-jointed; first maxillae bipartite, without a palp; second maxillae and maxillipeds close to the mouth-tube and strongly uncinate; all the appendages pointing diagonally downward and forward.

Type.—*Clavella uncinata* (Müller).

(*Clavella*, the diminutive of *clava*, a club.)

Remarks.—In his Lehrbuch der Naturgeschichte (1815) Oken first proposed (p. 182) three genera for the Lernaeans, *Phyllina*, *Schisturus*, and *Lernaea*. Under the second name he included 15 species which had been previously included in the genus *Lernaea;* among these was Müller's *Lernaea uncinata.* But Rudolphi had used the name *Schisturus* in 1809 for a genus of worms, and perhaps Oken became aware of this. At all events he presented later in the same book (p. 357) a much better classification of the Lernaeans, which he divided into four genera, *Axine, Clavella, Pennella,* and *Lernaea.* For the second of these genera which was new to science he took as the type *Clavella uncinata.*

In 1822 Blainville, overlooking or neglecting Oken's work, established (p. 438) a new genus which he called *Lernaeomyzon,* and of which he also made Müller's *Lernaea uncinata* the type.

In 1830 Cuvier, in his Le Règne Animal, adopted Oken's genus *Clavella* (vol. 3, p. 258) and included in it Müller's two species *uncinata* and *clavata.* But he also established (p. 257) a new genus which he named *Anchorella,* and for which he gave the following diagnosis: "Ne se fixe aux ouïes que par une seule productio qui part du dessous du corps, et se derige en arrière." He made Ström's *Lernaea adunca* the type of this new genus, which, of course, he claimed to be generically distinct from Oken's *Clavella.*

Krøyer in his Naturhistorisk Tidsskrift (1837) shuffled these genera in a very arbitrary and reckless manner. Under the Lernaeoda (vol. 1, p. 193) he placed as the first genus, "1. *Anchorella* (Cuv., *Clavella* Oken, *Lernaeomyzon* Blainv.). Arter: *Anch. uncinata* Fabr. *Anch. lagenula* Guérin. *Anch. microcephala* Nordm."

As the seventh genus he placed "*Clavella* Oken, Arter: *Cl. hippoglossi* Cuv. *Cl.* ? *clavata* Mull." (p. 195). He added in a footnote on the same page, "This genus was not included by Blainville, probably in the belief that it was identical with *Anchorella,* because Müller's *L. uncinata,* which Cuvier referred to the genus *Clavella,* really belongs to *Anchorella;* but this is not the case with *Cl. hippoglossi.* Whether it may be with *L. clavata* I can not say definitely, since I have not seen it, and Müller's description is unsatisfactory." Krøyer thus made Oken's *Clavella* a synonym of Cuvier's *Anchorella,* and then later established it as a distinct genus. He took the type-species of *Clavella* and made it the type of *Anchorella,* while he established as a new type for *Clavella* Guérin's species *hippoglossi.* Milne Edwards and subsequent writers, until recently, have followed Krøyer's arrangement, wholly ignoring Cuvier's generic distinction as well as the genera of Blainville and Oken.

The *Lernaea adunca,* which Cuvier made the type of the genus *Anchorella,* was described and figured by Ström in 1762, but has never been seen by any subsequent observer. So far as can be determined from Ström's description and figures the species is identical with *uncinata.* If the two really are the same, *Anchorella* becomes a synonym of *Clavella;* if they are not identical, both genera are valid, but the genus *Anchorella* can not possibly include *uncinata* and its relatives, as has been the common usage.

Synonyms.—To this illegitimate genus *Anchorella* has been referred indiscriminately a heterogeneous collection of more than 50 species, among which we must recognize at least three new genera. These species furnish one of the most convincing proofs that could be given of the lax methods adopted in dealing with the Lernaeopods. There are 16 species which are mere names, having never been either described or figured, one the data with reference to which do not justify us in locating it anywhere, 7 which can be located with probability, but not certainty, and 18 which must be transferred to other genera. This leaves only 17 out of the original 52, and to them are added 9 others which are new to science.

Anchorella carusi, characis, clava, crassa, elongata, lichiae, simplex subtilis, and *tenuis* were simply named in Richiardi's "Catalogo sistematico dei Crostacei." Brian afterwards described (1906, p. 113) and figured (pl. 10, fig. 5) Richiardi's *characis*, so that it can be definitely located in the genus *Clavella*, where he placed it. He also mentioned the other species, but without describing or figuring them.

Anchorella adunca has been noted above.

The following four species were described and figured by Krøyer (1863), *Anchorella agilis* (p. 300, pl. 16, fig. 2); *A. angulata* (p. 293, pl. 15, fig. 3); *A. denticis* (p. 296, pl. 16, fig. 4); *A. pagelli* (p. 295, pl. 16, fig. 3). The last two appear in Brian's "Copepodi parassiti dei pesci d'Italia," but his additions to Krøyer's descriptions consist of a few details with reference to the maxillipeds.

We have no data on the mouth parts, the antennae, or the male of either of the four species. *A. agilis* has been found by several collectors off the coast of Greenland (see Stephensen, 1913, p. 339), but nothing has been added to Krøyer's meager description. The four probably belong to *Clavella*, but there can be no certainty until these additional data are forthcoming.

Anchorella (*Lernaea*) *anomala* was described and figured by Abildgaard (1794, p. 57, pl. 6, fig. 2), who of course placed it in the genus *Lernaea*. Milne Edwards said of it:

> Le *Lernea anomala* d'Abildgaard paraît appartenir aussi á ce genre [*Anchorella*], mais différerait de toutes les espèces précédentes par la longueur considérable de l'organe d'adhésion, et par l'existence d'un renflement en forme de nœud à l'extrémité antérieure du thorax (1840, p. 520).

But of course this is not enough to identify the species and it also must await further details.

Anchorella appendiculata and *A. appendiculosa* (Krøyer, 1863, pp. 305 and 306, pl. 16, figs. 6 and 7) were each founded on a single specimen and no others have ever been obtained. The details given are sufficient to show that these species do not belong to the present genus. The four posterior processes, the second antennae, and the maxillipeds show a greater affinity with *Brachiella* than with *Clavella,* and accordingly the species are transferred to that genus. Krøyer claimed to have found a male of *appendiculata,* but put a question mark after the sex. So far as can be determined from his figures and description this "male" was simply a piece of the skin of the host and was not even anything alive.

Anchorella canthari Heller (1865, p. 242, pl. 24, fig. 6) almost certainly belongs to the genus *Clavella.* Heller does not give very many details in his brief description, but the additional data and the excellent figures of T. and A. Scott (1913, p. 224, pl. 69, figs. 1 to 3) are sufficient to locate it accurately.

Anchorella centrodonti van Beneden (1870, p. 43) was figured (pl. 2, fig. 5), but not described, and as far as the figure shows, appears to be a synonym of *pagelli.*

Anchorella dilatata Krøyer (1863, p. 302, pl. 15, fig. 2) shows several exceptional characters, notably the biramose second antennae and the body lobes on either side of the abdomen. If the details be just as Krøyer has described them, it differs considerably from *Clavella,* but can not be established elsewhere on our present knowledge.

Anchorella emarginata Krøyer (1837, p. 287, pl. 3, fig. 7) is here referred to the new genus *Clavellisa* (see p. 694).

Anchorella fallax Heller (1865, p. 241, pl. 24, figs. 4 and 5) is here referred to the new genus *Clavellopsis* (see p. 687).

Anchorella hostilis Heller (1865, p. 243, pl. 24, fig. 7) is certainly not a *Clavella,* and probably belongs to the genus *Brachiella* (see p. 702), but the male is needed for positive determination.

Anchorella intermedia Quidor (1906, p. 29, pl. 3, figs. 37 to 44) has biramose second antennae and slender maxillipeds, not reinforced. The male also corresponds with that of the genus *Clavellodes* but differs markedly from a *Clavella* male. The species, therefore, should be placed in the new genus *Clavellodes* (see p. 690).

Anchorella laciniata Krøyer (1863, p. 308, pl. 16, fig. 18) is here referred to the new genus *Clavellopsis* (see p. 687).

Anchorella lagenula Guérin (1817, pl. 9, fig. 5) is a synonym for *C. uncinata.*

Anchorella lizae Krøyer (1863, p. 294, pl. 16, fig. 11) belongs to the genus *Naobranchia* (see p. 660).

Clavella macrotrachelus Brian (1906, p. 116, pl. 21, figs. 1 to 4) is not a *Clavella,* as is shown by the male, and is referred to the new genus *Clavellodes* (see p. 690).

Anchorella microcephala was named by Nordmann (1832, p. 107), but was never described or figured.

Clavella obesa Richiardi (1880, p. 152) was named but never described or figured. It probably belongs to the genus *Hatschekia* and not to *Clavella.*

Anchorella ovalis Krøyer (1837, p. 289, pl. 3, fig. 6) belongs to the new genus *Clavellisa* (see p. 696).

Anchorella paradoxa van Beneden (1851, p. 117, pl. 6, fig. 1) is here referred to the new genus *Clavellopsis* (see p. 687).

Anchorella quadrata Bassett-Smith (1896, p. 15, pl. 4, fig. 5) is probably a *Clavella* and is retained in that genus, although it is very meagerly described.

Clavella robusta Wilson (1912, p. 96, pl. 8, figs. 73 to 78) has biramose second antennae and short posterior processes similar to those of Krøyer's *Anchorella laciniata.* It can not, therefore, remain in the genus *Clavella,* but must be transferred to the new genus *Clavellopsis* (see p. 688).

Anchorella rugosa Krøyer (1837, p. 284, pl. 3, fig. 14) is not a *Clavella* and is made the type of the new genus *Clavellodes* (see p. 690).

Anchorella sargi Kurz (1877, p. 393, pl. 25, figs. 5, 6, 29, 51, 52) is also not a *Clavella,* and is transferred to the new genus *Clavellopsis* (see p. 687).

Clavella sciaenae Brian (1906, p. 119, pl. 10, fig. 2; pl. 20, figs. 13, 14) is probably identical with Heller's *Anchorella sciaenophila* as Brian suggests. The presence of four posterior processes and the details of the antennae and mouth parts indicate that it should be transferred to the genus *Brachiella.* Here also the male must finally decide where the species belongs.

Anchorella sciaenophila Heller (1865, p. 243, pl. 24, fig. 8) is here transferred to the genus *Brachiella,* as just stated (see p. 703).

Anchorella scombri Kurz (1877, p. 403, pl. 25, figs. 12, 35, 41) is not a *Clavella* and is referred to the new genus *Clavellisa* (see p. 694).

Anchorella stellata Krøyer (1838, p. 142, pl. 3, fig. 5) is probably a *Clavella,* and may be left there until further data can be obtained.

Clavella strumosa Brian (1906, p. 112, pl. 9, figs. 4 to 7) is not a *Clavella* and is referred to the new genus *Clavellopsis* (see p. 687).

Anchorella triglae Kurz (1877, p. 404, pl. 35, figs. 13 to 15) was first described by Claus as a *Brachiella* (see p. 702), and was transferred by Kurz to *Anchorella.* The male shows conclusively that it belongs where Claus placed it.

Anchorella urolophi Krøyer (1863, p. 304, pl. 16, fig. 10) also presents marked exceptions to the *Clavella* characters. The second antennae are biramose, and there is a two-jointed abdomen with well-developed anal laminae. These furnish serious reasons for excluding it from the genus *Clavella,* but they do not tell us where it ought to be placed.

TABLE OF SPECIES.

1. Cephalothorax definitely longer than the trunk.............................. 2.

1. Cephalothorax about the same length as the trunk or shorter.................. 8.

2. Trunk as wide as, or wider than, long; base of neck somewhat differentiated from the rest of the thorax; second maxillae lacking, bulla on the body; egg strings long, tapering.. 3.

2. Trunk as wide as, or wider than, long; base of neck not differentiated; second maxillae as long as the cephalothorax; egg strings short and stout.......... 4.

2. Trunk definitely longer than wide; base of neck not differentiated; second maxillae lacking, bulla on the body; egg strings long and tapering.............. 5.

3. Genital process exceptionally large and prominent; maxillipeds small; head pointed; egg strings straight......................*perfida*, new species, p. 672.

3. Genital process medium-sized; maxillipeds small; head swollen and bluntly rounded; each egg string curled until its ends nearly touch each other. *characis* (Richiardi), 1880, p. 668.

4. Second maxillae completely fused; neck smooth; genital process large. *inversa* Wilson, 1912, p 673.

4. Second maxillae separate at their bases; neck and arms very rough; genital process minute.......................................*pagri* (Krøyer), 1863.

4. Second maxillae separate at their tips; neck and arms smooth; genital process minute...*stichaei* (Krøyer), 1863.

5. Cephalothorax flexed back so tightly as to form a longitudinal groove on the dorsal body surface; head swollen; egg strings long and slender............ 6.

5. Cephalothorax not turned back against the trunk; no dorsal groove; head not enlarged; egg strings short and stout.. 7.

6. Second maxillae entirely lacking; trunk pear-shaped, much narrowed and wrinkled anteriorly; genital process minute........*agilis* (Krøyer), 1863, p. 668.

6. Second maxillae very short; trunk ovoid or ellipsoidal, smooth and plump; genital process minute.................................*bergyltae* (Krøyer), 1863.

6. Second maxillae entirely lacking; trunk oblong, no wrinkles; genital process one-third the length of the trunk....................*tumida*, new species, p. 674.

6. Second maxillae one-third the length of the cephalothorax; trunk ovoid, not wrinkled; genital process of medium size.....*canaliculata*, new species, p. 675.

7. Second maxillae entirely lacking; cephalothorax stout and wrinkled posteriorly; genital process of medium size ....*parva* Wilson, 1912, p. 676.

7. Second maxillae entirely lacking; trunk nearly spherical; genital process minute. *canthari* (Heller), 1865, p. 669.

7. Second maxillae quarter as long as cephalothorax; trunk ellipsoidal, twice as long as wide; genital process wanting.............*insolita*, new species, p. 676.

7. Second maxillae half as long as cephalothorax; trunk ovoid, nearly three times as long as wide; genital process wanting.............*levis*, new species, p. 677.

8. Genital process lacking; second maxillae medium length...................... 9.

8. Genital process present; second maxillae short, often lacking................ 11.

9. Trunk as wide as, or wider than, long; second maxillae partly or wholly separated.......................................*angulata* (Krøyer), 1863, p. 668.

9. Trunk distinctly longer than wide; second maxillae completely fused for their entire length.. 10.

10. Trunk ellipsoidal, twice as long as wide, and evenly rounded; bulla a large flattened disk with stellate perforations.............*stellata* (Krøyer), 1838, p. 670.

10. Trunk ellipsoidal, twice as long as wide, and evenly rounded; bulla minute and spherical..*pinguis*, new species, p. 678.

10. Trunk pear-shaped, three times as long as wide; second maxillae covered with scales...............................*squamigera*, new species, p. 679.

11. Cephalothorax thick and stout; trunk nearly as wide as, or wider than, long. 12.
11. Cephalothorax slender and linear; trunk considerably longer than wide...... 13.
12. Genital process of extraordinary size, fully as large as one of the egg strings. *quadrata* (Bassett-Smith), 1896.
12. Genital process one-quarter the length of the trunk; second maxillae completely fused; egg strings one-third longer than the trunk. *uncinata* (Müller), 1776, p. 680.
12. Genital process a mere ridge, scarcely projecting; second maxillae completely fused; egg strings shorter than the trunk.............*recta*, new species, p. 684.
12. Genital process one-eighth the length of the trunk; second maxillae separate, the base of each surrounded by a large wing.................*alata* Brian, 1906.
12. Genital process one-eighth the length of the trunk; second maxillae entirely fused, without wings; head pointed forward, parallel with trunk axis. *brevicollis* (M. Edwards), 1840.
13. Trunk ellipsoidal, smoothly rounded posteriorly; bulla an elongate club; egg strings narrow and tapered posteriorly.................*pagelli* (Krøyer), 1863.
13. Trunk ellipsoidal, flattened, with a fleur-de-lis on the ventral posterior margin; egg strings narrow and cylindrical..................*irina*, new species, p. 685.
13. Trunk ovoid, narrowed anteriorly, truncated posteriorly; egg strings thick ellipsoids.......................................*denticis* (Krøyer), 1863.
13. Trunk ellipsoidal, smoothly rounded posteriorly; bulla a sphere; egg strings long cylinders................................*dubia* (T. and A. Scott), 1913.

CLAVELLA PERFIDA, new species.

Plate 45, figs. 140 to 143.

Host and record of specimens.—An adult female with egg strings, and one attached male, and a young female with four attached males were obtained from the gills of an Alaskan pollack, *Theragra chalcogramma*, September 27, 1906, from a depth of 52 fathoms in the northwest Pacific. The adult specimen is made the type of the species and numbered 43505, U.S.N.M. The younger female, with the attached males, is numbered 43589, U.S.N.M.

Specific characters of female.—Cephalothorax much swollen and inflated, longer than the trunk and tapering gradually from the base to the tip, bent back dorsally against the trunk; head not enlarged, narrowed anteriorly; no dorsal carapace; base of neck with one or two constrictions, as though segmented; trunk much wider than long, convex ventrally, concave dorsally; genital process relatively large and prominent, on a level with the ventral surface; egg strings half as long again as the trunk, tapering slightly posteriorly; eggs arranged in 12 to 14 longitudinal rows, about 25 eggs in each row.

First antennae indistinctly three-jointed, wholly inside the second pair, tipped with a tuft of small setae; second antennae uniramose, the terminal joints bent across the frontal margin and almost touching at the midline; mouth tube reaching the posterior margin of these antennae, broad and stocky; first maxillae tripartite, with a small and poorly developed palp; second maxillae entirely lacking, the attachment bulla being fastened to the surface of the trunk at the base of the neck; opposite this bulla are the maxillary glands in the form of a club-shaped projection on either side, pointing diagonally outward and ventrally; maxillipeds with a triangular basal joint and a long and stout terminal claw, bent abruptly near the tip and armed there on the inner margin with an accessory spine.

Color (preserved material), a uniform yellowish-white.

Cephalothorax, 2.75 mm. long, 1 mm. wide. Trunk, 1.75 mm. long, including the genital process, 2.1 mm. wide. Egg strings, 3 mm. long.

Specific characters of male.—General body form, egg-shaped, quite pointed at the smaller end and evenly rounded at the larger end; first antennae two-jointed, well supplied with setae; second antennae indistinctly three-jointed, with two short setae at the tip; these antennae reach about to the center of the mouth tube, which is broad at the base, proportionally long, and inclined at an angle of 45° with the body axis; first maxillae bipartite at the tip, with a third ramus on the inner margin; second maxillae and maxillipeds of the usual pattern. Just behind the second maxillae a drop of the cement substance, which forms the covering of the spermatophores, has exuded from the genital orifice and hardened in the preservative.

Color (preserved material), a uniform yellowish-white.

Total length, including the mouth tube, 0.57 mm. Width, 0.33 mm.

(*perfidus*, deceitful, alluding to the apparent segmentation at the base of the neck, the external maxillary glands, and the apparent genital process on the male.)

Remarks.—The first two of the peculiarities just mentioned will serve to distinguish this species from all others of the genus, and as the Alaska fish become better known this parasite is likely to be found more abundantly.

CLAVELLA INVERSA Wilson.

Clavella inversa WILSON, 1913, p. 231, pl. 50.

Host and record of specimens.—Six females with egg strings were obtained from the gills of the red-mouthed grunt, *Bathystoma rimator* July 18, 1910, at Montego Bay, Jamaica. The type-specimen was numbered 43513, U.S.N.M., while the paratypes were numbered 42291, U.S.N.M. A single adult female was taken by Dr. Edwin Linton from the gills of a croaker, *Micropodon undulatus*, at Beaufort, N. C., August 20, 1902. It is numbered 39610, U.S.N.M.

Remarks.—The host of this species is abundant along the Atlantic coast of the Southern States, particularly the Carolinas, where it is one of the common food fishes. Probably, therefore, an examination of these fishes in the markets or elsewhere would reveal a greater number of the parasites. The species may be recognized by the genital process, and by the distinctly undersized appearance of the body and egg strings when compared with the second maxillae and cephalothorax.

CLAVELLA TUMIDA, new species.

Plate 45, figs. 144 to 147; plate 46, fig. 148.

Host and record of specimens.—A single female without egg strings, but with two attached males, was obtained from the gills of the tomcod, *Microgadus tomcod* at Harpswell, on the Maine coast, July 17, 1903. It of course becomes the type of the new species, and is numbered 39592, U.S.N.M.

Specific characters of female.—Cephalothorax swollen, slightly flattened dorso-ventrally, and flexed back against the dorsal surface of the trunk so tightly that it makes a groove along the median line of the latter. On either side of this groove the body rises into a ridge, which apparently increases the depth of the groove; head considerably swollen, and covered with a distinct dorsal carapace; trunk flattened dorso-ventrally, oblong, with rounded corners; ventral surface flat, with a well-defined central ridge of longitudinal muscles; dorsal surface with the two lateral ridges and the central groove as just stated; genital process relatively large, club-shaped, and attached on a level with the ventral surface. First antennae indistinctly three-jointed, the basal joint considerably swollen and attached a long distance inside of the second antennae and close to the mouth tube. Second antennae uniramose, the basal joints much enlarged and stiffened with a chitin framework, the terminal joints turned inward at right angles across the frontal margin and almost touching at the midline. Mouth tube short, narrow at the base and tip, and swollen through the center; first maxillae tripartite at the tip, the outer ramus very rudimentary; palp also small and armed with a single seta. Second maxillae practically wanting, only forming a bowl-shaped depression in the base of the neck; bulla of medium size, and spherical, fastened to the bottom of the bowl by a short pedicel; maxillipeds small, with a swollen basal joint and a slender terminal claw, bent sharply close to the tip, and armed there on the inner margin with an accessory spine.

Cephalothorax, 3 mm. long, 0.5 wide. Trunk, 2.5 mm. long, 1.25 mm. wide. Genital process, 0.6 mm. long.

Specific characters of the male.—Body somewhat egg-shaped, but considerably straightened along the ventral margin; mouth tube at the small end and projecting downward and forward at an angle of 45° with the body axis; the two pairs of antennae removed a long distance from the anterior margin and close together; first pair three-jointed, the third joint very narrow and more like a swollen seta; second pair with a short basal joint and one-jointed rami, the exopod slightly longer than the endopod and both armed with minute spines;

mouth tube more than twice as long as the second antennae and very broad at the base; first maxillae bipartite and slender, without a palp; second maxillae much longer than the maxillipeds and rather slender, armed with fleshy blunt processes rather than with claws; maxillipeds with a swollen basal joint and a small and curved terminal claw, whose tip fits into a pocket on the basal joint.

Color (preserved material), a uniform grayish-yellow.

Total length, 0.39 mm. Greatest width, 0.30 mm.

(*tumidus*, swollen, applying to the head and genital process of the female and the maxillipeds of the male.)

Remarks.—This species is rare, for out of an examination of more than 100 fish the type-specimen was the only one obtained.

It may be distinguished by its general swollen appearance, by the reentrant frontal margin of the head, and by the large genital process.

CLAVELLA CANALICULATA, new species.

Plate 46, figs. 149 to 151.

Host and record of specimens.—A single female with egg strings and an attached male was obtained from the pectoral fin of the California tomcod, *Microgadus proximus*, at Yakutsk Bay, Alaska.

It becomes the type of the new species, and has received the number 39601, U.S.N.M.

Specific characters of female.—Cephalothorax slender, cylindrical, considerably longer than the trunk, and turned back against the dorsal surface of the latter; head and adjacent portion of the neck enlarged and squarely truncated anteriorly; no dorsal carapace; trunk elongate-ovate, somewhat flattened dorso-ventrally with a deep groove on the dorsal surface into which the cephalothorax fits, and a groove near the posterior end on either side, out of the bottom of which the oviduct opens; genital process of medium size, and inclined outward and backward; egg strings about the same length as the trunk and tapered posteriorly; eggs arranged in 8 longitudinal rows, about 20 eggs in a row.

Second antennae uniramose, the terminal joints turned down across the frontal margin and meeting at the midline; second maxillae in line with the cephalothorax, about one-quarter the length of the latter, fused into a common cylinder for their entire length and somewhat enlarged at the tip; bulla spherical and almost sessile; maxillipeds placed far forward and covering the mouth tube, first antennae and first maxillae, basal joint stout, terminal claw slender, with an accessory claw on the inner margin near the tip.

Cephalothorax 3 mm. long, 0.45 mm. wide. Trunk 2.5 mm. long, 1.5 mm. wide, 1 mm. thick. Egg strings 2.55 mm. long, 0.625 mm. wide.

Specific characters of male.—Body egg-shaped, quite pointed anteriorly, no dorsal carapace; first antennae with a rudimentary endopod and indistinctly jointed; endopod of second antennae also rudimentary, exopod ending in two setae; mouth tube pointing forward in line with the body axis and about twice the length of the first antennae; first maxillae bipartite at the tip and without a palp; second maxillae long and narrow, contrasting strongly with the short and stocky maxillipeds.

Color (preserved material), yellowish-white.

Total length, 0.45 mm. Greatest width, 0.30 mm.

(*canaliculatus*, grooved, alluding to the large groove down the center of the back, into which the cephalothorax fits.)

Remarks.—The first antennae are partially, and the first maxillae are entirely, hidden by the maxillipeds in the female, and it was not considered advisable to mutilate the type-specimen for the sake of getting at the first maxillae. The species is sufficiently distinguished by the deep dorsal groove and the wide and inclined genital process of the female.

CLAVELLA PARVA Wilson.

Clavella parva Wilson, 1912, p. 95, pl. 8, figs. 66 to 72.

Host and record of specimens.—Ten females with egg strings were obtained from the soft dorsal fin of the brown rockfish, *Sebastodes auriculatus*, at Nanaimo, British Columbia. Six of the specimens were selected as types of the species and numbered 39525, U.S.N.M.

Remarks.—This species may be distinguished by its minute size, and by the form of the first maxillae, which are bipartite at the tip, each ramus ending in two setae, with a fifth seta on the outer margin; palp short and ending in two setae.

CLAVELLA INSOLITA, new species.

Plate 46, figs. 152 and 153.

Host and record of specimens.—Two females with egg strings were obtained from the pectoral fin of *Leptoblennius serpentinus*, the snake blenny, at Woods Hole, Massachusetts, dredged from a depth of 41 fathoms. The largest female is made the species type and is numbered 39607, U.S.N.M.

Specific characters of female.—Cephalothorax in line with the second maxillae, slender, cylindrical, slightly swollen at the base and smooth; head not enlarged, squarely truncated anteriorly, and without a dorsal carapace; trunk ellipsoidal, one-third shorter than the cephalothorax, with a row of shallow transverse wrinkles along either side of the midline on the ventral surface; genital process partially separated inside the skin but not showing externally; egg strings ellipsoidal, a little shorter than the trunk; eggs large, arranged in

8 longitudinal rows, about 10 or 12 eggs in a row. First antennae slender, indistinctly three-jointed, much swollen at the base, narrow at the tip, with but one or two setae; second antennae uniramose, with a slender, conical terminal joint, and a stout basal portion, reinforced with chitin ribs; mouth tube broad, but not projecting beyond the first maxillae; the latter bipartite at the tip, with a minute palp, bearing a single seta; second maxillae short, stout, and thoroughly fused for their entire length; bulla minute and spherical; maxillipeds with a long and fairly stout basal joint and a slender terminal claw, without spines or accessory claws; these maxillae are removed behind the mouth tube so that they do not overlap the other mouth parts.

Color (preserved material), dark cinnamon brown; egg strings red. Total length, excluding egg strings, 4.5 mm. Length of cephalothorax and second maxillae, 3 mm. Width, 0.5 mm. Trunk, 2.1 mm. long, 0.9 mm. wide. Egg strings, 1.6 mm. long; 0.5 mm. wide.

(*insolita*, unusual, alluding to the absorption of the genital process into the trunk.)

Male.—Unknown.

Remarks.—The host of this parasite is very rare as far south as Cape Cod, which would account for the limited number of specimens and the fact that it has never been discovered before.

CLAVELLA LEVIS, new species.

Plate 47, figs. 154 and 155.

Host and record of specimens.—Two females without egg strings were obtained from the pectoral fins of a "rare Brotulid" by the steamer *Blake* of the United States Coast Survey. The better of the two is made the species type with the number 43553, U.S.N.M. The other becomes a paratype, with the number originally given it, 6086, U.S.N.M.

Specific characters of female.—Cephalothorax slender and cylindrical, a little longer than the trunk; head not enlarged, pointed anteriorly, without a dorsal carapace; second maxillae in line with the cephalothorax and about half as long; trunk egg-shaped, about twice as long as wide and perfectly smooth, without ridges or processes of any kind. First antennae with the basal joint strongly swollen, the two terminal joints cylindrical, bent at an angle with the basal joint and tipped with two spines; second antennae uniramose, the joints diminishing rapidly in size from the base toward the tip. These antennae are not bent across the frontal margin as is usual, but are turned ventrally, the last joint bent inward and tipped with a tuft of setae. Mouth tube broadly conical, projecting a little beyond the anterior margin; first maxillae bipartite, with a small palp armed with a single seta; second maxillae fused entirely, but with the line of demarcation plainly visible; bulla relatively large and shaped like a wine glass; maxillipeds with a triangular basal joint and a slender curved terminal claw, with an accessory claw on its inner margin near the center.

Color (preserved material), a rich reddish-brown.

Cephalothorax, 3.5 mm. long, 0.5 mm. wide. Trunk, 3 mm. long, 1.35 mm. wide. Second maxillae, 1.25 mm. long.

(*levis*, smooth, alluding particularly to the absence of all ridges and processes at the posterior end of the trunk.)

Male.—Unknown.

Remarks.—The Brotulid hosts are not obtained often enough to tell how common these parasites may be on them. The species may be recognized by the smoothness of the posterior end of the trunk and by the peculiar form of the first and second antennae. The direction of the latter appendages ventrally instead of across the anterior margin is peculiar and is readily seen in a ventral view of the head.

CLAVELLA PINGUIS, new species.

Plate 47, figs. 156 to 161.

Host and record of specimens.—Fifteen females with egg strings and two males were obtained from the pectoral fins of "*Lycodes brunneus*" off the coast of New Jersey in the deep Atlantic. One female has been selected as the type of the new species and numbered 43594, U.S.N.M. The other specimens become paratypes and are numbered 8352, U.S.N.M. A second lot was obtained from the pectoral fins of "*Lycodes,* brown sp.," taken in the deep Atlantic close to the previous lot. There are three females, one very young and only 1.5 mm. in length; they are numbered 8351, U.S.N.M.

A third lot, containing ten females, was obtained from the pectoral fins of *Lycodes frigidus*, caught in the deep water off the coast of Nova Scotia. They are numbered 39606, U.S.N.M.

A fourth lot of two females was obtained from the same host off Nantucket Island and are numbered 43587, U.S.N.M.

A single female was obtained from the pectoral fin of a species of *Macrurus* in the deep water south of Buzzards Bay, Rhode Island. It is numbered 6074, U.S.N.M.

Specific characters of female.—Cephalothorax slender, cylindrical, and slightly longer than the trunk; head not enlarged nor differentiated from the neck; no dorsal carapace; trunk elliptical in outline, flattened dorso-ventrally, much longer than wide, without a genital process; external oviduct openings with deep grooves on both the dorsal and ventral surfaces; egg strings cylindrical, about the same length as the trunk; eggs small, in 8 or 10 longitudinal rows, about 25 or 30 in a row.

First antennae short and very indistinctly jointed; second antennae uniramose, turned down across the frontal margin, with the tips meeting at the midline; mouth tube wide and with its tip overlapping the second antennae; first maxillae long and slender, tripartite, the outer ramus much shorter than the others; palp short and armed with a single seta; second maxillae short and completely fused, tapering rapidly toward the tip; bulla small and spherical; maxillipeds with a long basal joint and a slender terminal claw, curved at the tip and carrying an accessory claw on its inner margin.

Color (preserved material), a deep brownish-yellow, eggs orange.

Cephalothorax, 4 mm. long, 0.5 mm. wide. Trunk, 3.5 mm. long, 1.5 mm. wide, 1 mm. thick. Egg strings, 3.5 mm. long, 0.62 mm. thick.

Specific characters of male.—Body egg-shaped, widest posteriorly; mouth tube long and pointed forward in line with the body axis; first antennae removed some distance from the dorsal margin and apparently only two-jointed; second antennae with one-jointed rami, both of which are armed with short processes rather than with spines; first maxillae long and slender and bipartite, without a palp; second maxillae and maxillipeds of the usual form.

Color (preserved material), a grayish-yellow.

Total length, 0.4 mm. Greatest width, 0.25 mm.

(*pinguis*, smooth, sleek.)

Young female.—Cephalothorax folded back against the dorsal surface of the trunk and one-third longer than the latter; head considerably enlarged through the bases of the maxillipeds; second maxillae in line with the cephalothorax and one-third the length of the latter, from which they are separated by a well-defined groove; bulla spherical, on a long pedicel; trunk cylindrical, the same diameter throughout, and perfectly smooth, without grooves or processes.

Remarks.—This species seems fairly common on the deep water forms of *Lycodes*. It may be distinguished by the long and narrow trunk, the absence of a genital process, and the deep grooves at the bases of the egg strings.

CLAVELLA SQUAMIGERA, new species.

Plate 48, figs. 162 to 166.

Host and record of specimens.—An adult female without egg strings was obtained from the tail fin of *Antimora viola*, August 5, 1884, in the deep water of the Atlantic opposite Atlantic City, New Jersey.

The cephalothorax of a second specimen was also obtained, but the trunk in some way was destroyed. The perfect specimen is made the species type and is numbered 39602, U.S.N.M.

Specific characters of the female.—Cephalothorax longer than the trunk and very slender; head not enlarged but tapered strongly anteriorly; no dorsal carapace; trunk pear-shaped, somewhat flattened dorso-ventrally, narrowed into a short neck anteriorly where it joins the cephalothorax, and with two posterior knobs, one at the mouth of each oviduct; no genital process.

First antennae pointing ventrally and apparently two-jointed, the terminal joint very small and tipped with three setae; second antennae uniramose, three-jointed, the two terminal joints turned down across the frontal margin and tapered to a point. The anterior margin of the head is so narrow and these antennae are so long that they overlap considerably at the midline. Mouth tube a broad cone, so short that it reaches only halfway to the second antennae; first maxillae bipartite at the tip, with a rudimentary palp, tipped with a single seta; second maxillae fused for their entire length, but with the line of demarcation plainly visible. Each maxilla is considerably swollen and bears at the tip and on the sides chitin scales, which point backward, away from the tip, and overlap one another like shingles. Bulla small, dark-colored, and club-shaped; maxillipeds with a narrow and elongate basal joint and a medium terminal claw, reenforced with an accessory spine on the inner margin near the center.

Cephalothorax, 6 mm. long, 0.4 mm. wide. Trunk, 4.66 mm. long, 2 mm. wide, 1 mm. thick.

(*squamigera*, *squama*, a scale, and *gero*, to bear, alluding to the remarkable scales on the second maxillae.)

Remarks.—This species can be recognized at once by the scales on the second maxillae, since nothing like them has been reported from any other species. They seem to increase both in size and in number with the age of the parasite. They bear some resemblance to the anchoring apparatus found on the heads of some of the *Lernaeidae*. But in the present instance they do not even touch the skin of the host, to say nothing of being buried in its flesh, since there is a normally functioning bulla at the tips of these maxillae. Their use is decidedly problematical.

CLAVELLA UNCINATA (Müller).

Plate 27, fig. M; plate 48, figs. 167 to 173; plate 49, figs. 174 to 176.

Lernaea uncinata Müller, 1776, p. 38, pl. 33, fig. 2.
Schisturus uncinatus Oken, 1815, p. 183.
Clavella uncinata Oken, 1815, p. 358.
Lernaeomyzon uncinata Blainville, 1822, p. 438.
Clavella uncinata Cuvier (Oken), 1830, p. 258.
Ancorella uncinata Nordmann, 1832, p. 102.
Anchorella uncinata Krøyer, 1837, p. 193, pl. 3, fig. 8, *a* to *f*.

Host and record of specimens.—The following list gives the hosts, localities, specimens, and numbers of the large collection of this species in the National Museum:

Cat. No.	Males.	Females.	Host.	Locality.
(1427)		15	Cod's fins	Woods Hole, Massachusetts.
(1445)		10	Cod's gills	Woods Hole, Massachusetts.
(1467)		5	Cod's gills	Woods Hole, Massachusetts.
(1508)		5	Cod's gills	Woods Hole, Massachusetts.
(1992)		6	Cod's gills	Commander Islands.
		2	Cod's gills	Sta. 2518, Steamer *Albatross*.
6118		4	Cod's gills	Georges Banks.
7990	30	25	Cod's gills	Marthas Vineyard.
7991		1	Cod's gills	Commander Islands.
7993		3	Cod's gills	Harpswell, Maine.
7994		1	Cod's gills	Harpswell, Maine.
7995		2	Cod's gills	Harpswell, Maine.
7996		3	Cod's gills	Harpswell, Maine.
7997		2	Cod's gills	Casco Bay, Maine.
7998		4	Cod's gills	Cornwall, England.
8347		20	Cod's gills	Coxs Ledge, Maine.
19893		30	Cod's gills	Woods Hole, Massachusetts.
20008		25	Cod's gills	Woods Hole, Massachusetts.
39568		15	Cod's fins	Woods Hole, Massachusetts.
39569		4	*Gadus macrocephalus*	Chignik Bay, Alaska.
39572		8	Pollack's gills	Casco Bay, Maine.
39584		10	Pollack's gills	Casco Bay, Maine.
39586		3	*Pollachium carbonarium*	Gloucester, Massachusetts.
39590		10	No host	No locality.
39593		2	Cod's mouth	Woods Hole, Massachusetts.
39598		5	Rock cod's gills	Harpswell, Maine.
39600		5	Cod's fins	Woods Hole, Massachusetts.
39605		6	Cod's gills	Brunswick, Maine.
39609		3	Cod's gills	Harpswell, Maine.
39623		1	Cod's mouth	Steamer *Albatross*.
42305		3	Cod's fins	Casco Bay, Maine.
42330		1	No host	No locality.
42334	2	3	Cod's gills	WoodsHole, Massachusetts.
43515		5	*Gadus macrocephalus*	Atka, Alaska.
43516	5	25	Cod's gills	Casco Bay, Maine.

Lot No. 7990 was remarkable for the fact that nearly every female had at least one attached male and a few had as many as three or four, usually fastened to the sexual process, sometimes to the neck, and in one instance to the egg string. The specimens in the two lots from the Pacific cod are similar in all respects to those from the Atlantic, but average larger in size.

Specific characters of female.—Cephalothorax cylindrical, the same diameter throughout, and a little longer than the trunk; head not enlarged nor narrowed, but squarely truncated anteriorly; no dorsal carapace; cephalothorax in line with the second maxillae and both attached to the extreme anterior end of the trunk; the latter more or less quadrilateral, with rounded corners, flattened dorso-ventrally and somewhat reentrant at the center posteriorly; genital process on a level with the ventral surface and minute; egg strings cylindrical slightly tapering posteriorly, and varying from one to two and a half times the length of the trunk; eggs arranged in 10 or 12 longitudinal rows, from 15 to 35 in a row.

First antennae indistinctly three-jointed, tipped with two short setae, and close to the base of the mouth tube; second antennae uniramose, the basal joints lying along the sides of the head and supported by strong chitin ribs, the terminal joints bent squarely across the frontal margin, their tips just touching on the midline, their posterior margins in contact with the anterior ends of the maxillipeds. These terminal joints are also strengthened by stout chitin ribs, and their bluntly rounded tips are roughened by short spines. Mouth tube very short and narrow, actually withdrawn behind the ends of the maxillipeds; mandibles with a slender neck, a widened blade, and five or six large, sharply pointed and curved teeth; first maxillae short and slender, bipartite, the palp extremely rudimentary.

Second maxillae short, thoroughly fused, and furnished with a medium-sized spherical bulla; maxillipeds pushed forward until they completely overlap the mouth tube, first antennae and maxillae. They are rather small with a stout basal joint and a slender, curved terminal claw, which is twisted so that it shuts down on the dorsal surface of the basal joint, and is wholly invisible in ventral view.

Color, a uniform orange yellow, lighter in living specimens, much deepened and darkened on preservation in alcohol, especially the chitin framework of the second antennae.

Specific characters of male.—General body form ovoid, the head at the pointed end; cephalothorax folded ventrally against the trunk and the two indistinguishably fused, with no recognition of parts, no segmentation, no anal laminae, and no dorsal carapace.

First antennae two-jointed and tipped with two minute setae; second antennae with a long, three-jointed exopod, tipped with two or three short setae, and a rudimentary endopod, unarmed; mouth tube large and long, conical, projecting its entire length in front of the thorax; mandibles similar to those of the female; first maxillae narrow and slender, bipartite, ending in two long acuminate setae, the palp with a single seta; second maxillae long and narrow, projecting some distance beyond the maxillipeds, and armed with a short and slender claw; maxillipeds with a stout, triangular basal joint and a short and stout claw; the surface of the basal joint on the inner surface is raised up in a semicircular ridge, which forms a sheath, into which the tip of the claw fits when it is closed; between the maxillipeds on the median line is a short rounded process, similar to that noted by van Beneden in the male of *Brachiella,* and by Kane in the male of *Lernaeopoda.*

Color, a uniform yellowish-white.

Total length, 0.5 mm. Greatest width, 0.32 mm.

(*uncinata,* furnished with claws, alluding to the maxillipeds which had not been found on other Lernaeans).

Copepodid larva.—A single finely preserved specimen was found among a lot of adult males and females taken from the gills of a flounder. General body form similar to that of *Cyclops;* carapace a fusion of the first thorax segment with the head, ovate in shape, three-fifths of the entire length, with the anterior and posterior margins almost squarely truncated; posterior body made up of four segments of the same width, but the first and third are considerably shorter than the second and fourth (fig. 13, p. 593).

First antennae attached to the anterior corners of the carapace on the dorsal surface, three-jointed, the terminal joint as long as the basal ones. These antennae are turned back and approximated close to the sides of the carapace; the basal joint is armed with a single small spine, the terminal joint ends in a tuft of six spines, unequal in length. The second antennae project diagonally forward from beneath the bases of the first pair; they are two-jointed, the terminal joint being a stout acuminate claw, bent into a half circle and armed at its base on the ventral surface with a short spine. The mouth tube is cylindrical, of the same diameter throughout, and bluntly rounded at the tip. The mandibles are included in the tube and reach to its tip; they are slender, slightly enlarged at both ends, and furnished with a dozen small saw teeth, all about the same size.

Inside the base of the mandibles can be seen the tips of the new pair which are to appear at the next molt.

The first maxillae are attached to the ventral surface of the head, outside of and close to the base of the mouth tube. Each is composed of two rami of the same length, the exopod being stout and conical and ending in a single spine, the endopod slender and cylindrical and ending in two long equal spines (fig. 14, p. 594).

The second maxillae are two-jointed, the basal joint longer and stouter than the terminal joint; they end in a blunt claw which is bent strongly near the base. The maxillipeds are longer and more slender than the second maxillae, the basal joint much stouter than the terminal; the latter ends in a slender, acuminate claw, only slightly bent, with a small spine on the ventral surface at its base. Both pairs of legs are biramose, the rami one-jointed; the basal joints carry a long threadlike spine on the outer margin; the exopods are armed with two long and two short spines on the outer margin, the latter fringed with fine teeth, and four plumose setae at the tip; the endopods have a single small spine at the outer distal corner and six plumose setae, one of which is removed from the other five and appears on the inner margin close to the base.

Remarks.—This is the oldest species, and therefore an appropriate type of the genus. Its history has already been given under the genus remarks (see p. 667). It is so common that it has been at least mentioned by almost everyone who has dealt with the parasitic copepods. And yet it is surprising to find that it has never been described in any detail, while the best figures that have been published are either too small to show the detail (Krøyer, 1837), are taken at such an angle as to give a poor idea of the real structure (Vogt, 1877), or are buried in a general treatise (Claus, 1861) whence it is difficult to extract those that belong to any definite species. The same is found to be true of the male; Vogt copied Nordmann's and Krøyer's figures which gave incorrect details, and in the enlarged figure which he himself added (1877, pl. 4, fig. 4) he made some serious blunders which have remained uncorrected up to the present time. This is the only detailed figure of the male which has ever been published, and yet in it the "first antenna" has no real existence, the "second antenna" is really the first one, and the "palp" is the second antenna, while he failed to see the first maxillae at all. He did see them in his figure of the mouth parts of the female (fig. 7), but he called them there the "palp," which would make them correspond in his judgment with the second antennae of the male.

CLAVELLA RECTA, new species.

Plate 50, figs. 183 and 184.

Host and record of specimens.—Seven females with egg strings were obtained from the dorsal and caudal fins of *Sebastodes melanops*, locally known as "black bass," at Sitka, Alaska, July 28, 1903.

The largest and best preserved specimen has been selected as the type of the species and has received the number 43519, U.S.N.M. The others become paratypes, with the number 38593, U.S.N.M.

Specific characters of female.—Cephalothorax thick, cylindrical, somewhat longer than the trunk; head not enlarged, nor covered with a dorsal carapace, but pointed anteriorly; trunk subquadrilateral in outline, with rounded corners and convex dorsal and ventral surfaces; genital process a ridge or lump not projecting much, bordered by a similar ridge on either side, the two side ones meeting at a point in front of (ventral to) the median one; egg strings ellipsoidal, about the length of the trunk; eggs arranged in 10 or 12 longitudinal rows, about 15 eggs in each row.

First antennae indistinctly three-jointed and sparsely armed with setae; second antennae uniramose and straight, not bent across the frontal margin. The antennae themselves taper strongly toward the tip and the lateral margins of the head approach each other anteriorly, so that the ends of these antennae almost meet on the midline, but there is no bend in them.

First maxillae bipartite, with a simple palp armed with a single seta; second maxillae very short, entirely fused, but with the line of demarcation clearly indicated; they are not in line with the cephalothorax but are parallel with the trunk axis; bulla minute, spherical, dark-colored; maxillipeds with a rather long basal joint and a slender terminal claw, which is reinforced by an accessory claw on its inner margin near the tip. These maxillipeds are relatively small and are pressed closely to the ventral surface of the head, so that it is difficult to distinguish them, even in a side view.

Male.—Unknown.

Color (preserved material), a uniform grayish-yellow. Cephalothorax, 3 mm. long, 0.5 mm. wide. Trunk, 2.25 mm. long, 2 mm. wide. Egg strings, 2 mm. long, 0.90 mm. wide.

(*rectus*, straight, alluding to the second antennae.)

Remarks.—The pointed head, the straight second antennae, and the tiny maxillipeds serve to distinguish this species from those previously described. It adds one more to those obtained on fish from the Pacific coast.

CLAVELLA IRINA, new species.

Plate 49, figs. 177 to 181.

Host and record of specimens.—Two adult females with egg strings and an attached male were taken from the gill cavity of the Pacific cod, *Gadus macrocephalus*, at Chignik Bay, Alaska, August 7, 1903, by Dr. Harold Heath. The more perfect one is made the type of the species and is numbered 43568, U.S.N.M. The other female becomes a paratype and is numbered 39570, U.S.N.M.

Specific characters of female.—Cephalothorax slender and cylindrical, the same diameter throughout and longer than the trunk; no dorsal carapace; trunk oblong, flattened dorso-ventrally, with rounded corners; genital process on a level with the ventral surface, ellipsoidal, flanked on either side at its base with a curved process, the three together forming a conventional fleur-de-lis; egg strings cylindrical, tapering posteriorly, the same length as the trunk; eggs in 6 longitudinal rows, about 40 in a row.

First antennae indistinctly three-jointed, thick at the base and tapering, with three short terminal setae; second antennae uniramose, with a long and stout basal joint and a short terminal joint bent across the anterior margin, but not at a right angle.

The tips of these antennae do not quite meet on the midline and are roughened with minute spines. Mouth tube relatively much larger than in *uncinata*, and projecting beyond the second antennae; first maxillae bipartite, with a small palp bearing a single seta. Second maxillae not in line with the cephalothorax but parallel with the axis of the trunk, short, tapering, completely fused, but with the line of demarcation plainly visible; bulla small, club-shaped. Maxillipeds with a moderately swollen basal joint and a slender, curved terminal claw, carrying an accessory claw on its inner margin near the tip. These maxillipeds are close to the mouth tube as in *uncinata*, but they do not cover the mouth parts quite so completely.

Color (preserved material), a uniform yellowish-white.

Cephalothorax, 7 mm. long, 0.85 mm. wide. Trunk, 6.40 mm. long, 3 mm. wide, 2 mm. thick. Second maxillae, 1.6 mm. long. Egg strings, 8 mm. long.

Specific characters of male.—Body egg-shaped, more pointed anteriorly than that of *uncinata* and not as evenly rounded posteriorly, with the result that the thickest part of the egg comes, not through the bases of the second maxillae as in *uncinata*, but a considerable distance behind them; no dorsal carapace; mouth tube almost in line with the trunk axis and projecting its entire length in front of the anterior margin. First antennae three-jointed, with two terminal setae; second antennae with a long basal joint, a short exopod indistinctly jointed and tipped with two tiny spines, and a rudimentary endopod; first maxillae slender, bipartite, with a small palp carrying a single seta; second maxillae long and slender, with a small but powerful terminal claw; maxillipeds with a stout basal joint and a slender terminal claw, both appendages relatively smaller than in *uncinata*.

Color (preserved material), a dark yellowish-white.

(*irinus*, belonging to an iris flower, alluding to the fleur-de-lis pattern at the posterior end of the trunk.)

Remarks.—This species is quite different from *uncinata*, and may be recognized by its large size, by the fleur-de-lis pattern at the posterior end of the trunk and by the shape of the maxillipeds. It is evidently not a very common species.

CLAVELLOPSIS, new genus.

Generic characters of female.—General body form short, thick, and squat; cephalothorax distinctly separated from the rest of the body but much shorter and thicker than in *Clavella;* trunk inflated, often wider than long; genital process present and sometimes posterior processes, but no abdomen or anal laminae.

First antennae four-jointed, situated as in *Clavella;* second antennae biramose, the endopod (dorsal) one-jointed, the exopod (ventral) distinctly two-jointed and often tipped with a spine or olfactory cylinder; first maxillae bipartite, the palp usually with two setae; second maxillae with broad and winglike folds of skin at the base of the pedicel of the bulla; maxillipeds stout, the terminal claw usually reinforced by an accessory claw.

Generic characters of male.—Cephalothorax and trunk at right angles, the latter a semiellipsoid, strongly arched dorsally and flattened ventrally, with no distinction of parts and no dorsal carapace. First antennae three-jointed; second antennae biramose, each ramus unsegmented; mouth tube extending ventrally at right angles to the long diameter of the ellipse; first maxillae tripartite, without a palp; maxillipeds at about the center of the ventral surface; second maxillae posterior to them and pointing somewhat backward; no anal laminae.

Type.—*Clavellopsis* (*Anchorella*) *laciniata* (Krøyer).

(*Clavellopsis*, *Clavella* and ὄψις, appearance, likeness.)

Remarks.—The species which go to make up this new genus have heretofore been referred to the genus *Clavella*. But although their outward appearance is like that of *Clavella* there are certain details of structure which do not allow them to be included in that genus. The chief points of distinction are to be found in the four-jointed first antennae, the biramose second antennae, and the reinforced second maxillae of the female and in the general form of the male, together with the structure of the two pairs of antennae and the first maxillae.

TABLE OF SPECIES.

1. Cephalothorax distinctly longer than the trunk.............................. 2.
1. Cephalothorax the same length as, or shorter than, the trunk.................. 4.
2. Six posterior processes present; second maxillae entirely lacking, bulla attached to the surface of the trunk; egg strings half the length of the trunk. *laciniata* (Krøyer), 1863, p. 687.
2. No posterior processes; second maxillae present.............................. 3.
3. Neck and second maxillae swollen and much wrinkled; genital process minute. *fallax* (Heller), 1865, p. 669.
3. Neck and second maxillae swollen but smooth; genital process cylindrical and one-third the length of the trunk; egg strings short and stout......*sargi* (Kurz), 1877.
4. Two to six posterior processes; cephalothorax and trunk thick and swollen..... 5.
4. No posterior processes; cephalothorax swollen only at the base................ 6.
5. Cephalothorax flexed forward; genital process minute.*robusta* (Wilson), 1912, p. 688.
5. Cephalothorax flexed backward; genital process large..*paradoxa* (van Beneden), 1851.
6. Trunk spherical, flattened, nearly as wide as long; head with a dorsal carapace. *strumosa* (Brian), 1906.
6. Trunk cylindrical, flattened, six times as long as wide; no dorsal carapace. *producta*, new species, p. 688.

CLAVELLOPSIS LACINIATA (Krøyer).

Anchorella laciniata KRØYER, 1863, p. 308, pl. 16, fig. 8, *a* and *b*.
Clavella laciniata WILSON, 1913, p. 259, pl. 49.

Host and record of specimens.—Five females and two males were found attached to the skin in the roof of the mouth of the doctor fish, *Teuthis hepatus*, at Montego Bay, Jamaica. They have received Cat. No. 42310, U.S.N.M.

Remarks.—The female of this species was briefly described by Krøyer in 1863, and was not seen again until the summer of 1910, when both sexes were obtained by the present author in Jamaica, and were fully described and figured in the reference given above.

The species was then referred to the genus *Clavella*, but further study compels its separation and establishment as a distinct genus. And since this is one of the oldest and best known species it is made the genus type (see pl. 27, fig. K).

CLAVELLOPSIS ROBUSTA (Wilson).

Plate 49, fig. 182.

Clavella robusta Wilson, 1912, p. 96, pl. 8, figs. 73 to 78.

Host and record of specimens.—A single lot of six females with egg strings was taken from the gill cavity of the brown rockfish, *Sebastodes auriculatus*, at Nanaimo, British Columbia. The species types are in the collection of the National Museum and are numbered 39331, U.S.N.M.

Remarks.—This species was fully described and figured in the reference above given. It was then placed in the genus *Clavella*, but according to the new standards here established it must be transferred to the genus *Clavellopsis*, because its second antennae are biramose, with a two-jointed exopod, and there are very short posterior processes, similar to those in *laciniata*.

There is need of the male of this species before the systematic position can be finally determined.

CLAVELLOPSIS PRODUCTA, new species.

Plate 50, figs. 185 and 186.

Host and record of specimens.—Two females without egg strings were obtained by the Bureau of Fisheries steamer *Albatross* from the anal fin of *Nematonurus goodei* (Günther), July 21, 1884, in the deep Atlantic opposite Chesapeake Bay. One of these was badly injured when obtained; the other is made the type of the new species and is numbered 43524, U.S.N.M.

Specific characters of the female.—Cephalothorax in line with the second maxillae, smooth, slender, and considerably shorter than the trunk; head not enlarged, pointed anteriorly; no dorsal carapace; trunk much elongated, slender, smooth, slightly enlarged at the posterior end and smoothly rounded without ridges or processes of any sort. First antennae indistinctly jointed, with an enlarged base; second antennae biramose, the exopod short, one-jointed, and bluntly rounded, the endopod longer, two-jointed, and tipped with a short conical spine; mouth-tube broadly conical, projecting in front of the anterior margin, but not as far as the second antennae; first maxillae bipartite, the palp small and armed with a single seta; second maxillae much swollen, transversely wrinkled, and fused throughout their length, but with the demarcation plainly visible; bulla small, black, and conical, with a broad, wing-like fold of skin around its base; maxillipeds with a rather stout basal joint and a slender claw, curved near the tip, and with a notch and tooth on its inner margin near the center.

Color (preserved material), a dark cinnamon brown.

Cephalothorax and second maxillae, 8.40 mm. long, 0.60 mm. wide.

Trunk, 9 mm. long, 1.50 mm. wide near the center.

(*elongata*, elongate in its general proportions.)

Remarks.—This species is apparently quite rare, but we must remember that very few of the fish which serve as its host have ever been examined for parasites. It can be at once distinguished from other species by the narrow and elongate cephalothorax and trunk.

CLAVELLODES, new genus.

Generic characters of female.—Parasites of medium size (8 mm.); cephalothorax distinctly separated from and much larger than the trunk, and reflexed against the dorsal surface of the latter; head somewhat enlarged and separated from the neck by a well-defined groove; trunk plump, of varying length, without an abdomen, anal laminae or posterior processes. First antennae slender, three-jointed; second antennae biramose, destitute of claws; first maxillae tripartite, the palp with a single seta; second maxillae so short that the bulla is virtually on the trunk; terminal claw of maxillipeds reinforced near the tip by an accessory claw, behind which the margin is toothed for a distance.

Generic characters of male.—Of medium size (1 mm.); body folded upon itself so that the anterior and posterior portions are parallel, while the central portion is at right angles to them, the whole completely fused without any distinction of parts or segmentation; general form ellipsoidal, with the anterior margin almost squarely truncated; mouthparts and genital process crowded together along this margin; no anal laminae.

First antennae indistinctly four-jointed; second antennae biramose, endopod simple, exopod two-jointed; first maxillae similar to those of the female; second maxillae larger and more powerful than the maxillipeds, and pushed so far forward as to be even with, or in front of, the anterior margin of the head.

Type.—*Clavellodes rugosa* (*Anchorella rugosa* Krøyer).

(*Clavellodes*, *Clavella* and εἶδος, likeness or appearance.)

Remarks.—This new genus is established to include three species which have hitherto been referred to *Clavella*. They differ so much, however, from that genus in the structure of the second antennae, first maxillae and maxillipeds of the female, and in the general form and appendages of the male, that a new genus must be created to receive them. The internal structure of the male, as described and figured under the species *rugosa* (see p. 691), is peculiarly interesting, not only because it shows a marked difference from *Clavella*, but also on account of the structure and arrangement of the entire sexual apparatus. In the female of this new genus the head is widened by the formation of prominent lateral lobes, the second antennae are biramose, and the first maxillae are tripartite. In the male the body is so completely folded on itself that all the appendages and even the genital process are on the anterior margin, level with the anterior border of the head, and they all point forward parallel with the long axis of the body.

TABLE OF SPECIES.

1. Trunk longer than wide, smooth; cephalothorax slender, scarcely longer than the trunk; genital process present.................... *macrotrachelus* (Brian), 1906.
1. Trunk wider than long, much wrinkled; cephalothorax plump, half as long again as the trunk; no genital process.................. *rugosa* (Krøyer), 1837, p. 690.
1. Trunk the same width and length, smooth; cephalothorax in line with the trunk and the same length; genital process present......... *intermedia* (Quidor), 1906.

CLAVELLODES RUGOSA (Krøyer).

Plate 27, fig. L; plate 51, figs. 190 to 199.

Anchorella rugosa KRØYER, 1837, p. 284, pl. 2, fig. 7; pl. 3, fig. 14 *a* to *c*.—T. SCOTT, 1900, p. 176, pl. 8, figs. 45 to 48.

Host and record of specimens.—Ten females with egg strings and four attached males were obtained from the gills of the wolf fish, *Anarrhichas lupus*, off Race Point, Gloucester, July 25, 1879, in 31 fathoms of water. They have been given Cat. No. 39616, U.S.N.M.

Another lot consisting of 15 females was taken from the gills of the same host at Casco Bay, Me., July 16, 1873, and has been given Cat. No. 43592, U.S.N.M.

Specific characters of female.—Cephalothorax considerably longer than the trunk and bent backward against the dorsal surface of the latter; head distinctly separated from the neck by a well-defined groove, flattened dorso-ventrally, enlarged at the sides into two prominent lateral lobes, which reach forward to the bases of the first antennae; neck stout, cylindrical, and covered with transverse wrinkles; trunk subquadrate, flattened a little dorso-ventrally, and with its entire surface thrown up into ridges and furrows; anterior and posterior margins reentrant; bulla in the bottom of the hollow at the anterior end, genital orifice in a corresponding position at the posterior end; egg strings broad, nearly twice the length of the trunk, and tapering posteriorly; eggs arranged in 10 to 15 rows, about 20 eggs in each row.

First antennae three-jointed, the basal joint much wider and longer than the others; second antennae biramose, the endopod much larger than the exopod, and the two rami turned down across the frontal margin, with their tips just meeting at the midline; exopod two-jointed, endopod one-jointed, with the tip and frontal margin armed with short spines; mouth tube broad, strongly tapered, with its tip just touching the second antennae; first maxillae tripartite, the outer ramus much shorter and smaller than the other two; palp bent down across the front of the maxilla and tipped with a single seta; second maxillae so reduced as to leave the bulla on the surface of the trunk; maxillipeds with a stout basal joint, provided with powerful muscles and armed along its inner margin with several knobs and processes, irregularly arranged, and against which the terminal claw shuts; the latter is large and stout, with an accessory claw on the inner margin near the tip and behind it a row of short saw teeth.

Color (preserved material), grayish-yellow, egg strings orange.

Cephalothorax, 5 mm. long, 1.25 mm. wide. Trunk, 3.2 mm. long, 4 mm. wide. Egg strings, 6 mm. long.

Specific characters of male.—Body completely folded together and fused, so that all the appendages and the genital process are crowded along the frontal margin; general form an ellipsoid, flattened laterally and truncated anteriorly, with an even curvature and a smooth surface; no dorsal carapace, but a short central rostrum projecting over the mouth tube.

First antennae four-jointed, the basal joint much larger than the others; second antennae biramose, the exopod two-jointed and tipped with a tuft of short setae, the endopod smooth except for a single spine on the outer margin; first maxillae similar to those of the female; second maxillae large and stout, with a long and powerful terminal claw; maxillipeds shorter but just as strong.

The internal anatomy of this male is shown in figure 198 and may be described as follows: The esophagus (*oe*) is slender and nearly straight; its dorsal wall is only a single cell in thickness, while in the ventral wall two rows of nuclei may be seen, and there is a corresponding increase in thickness. The stomach (*s*) lies close to the dorsal surface and is abruptly and considerably enlarged at the anterior end. It passes insensibly into the intestine, which curves around the posterior part of the trunk, still close to the dorsal surface, and ends blindly at the point *e*. The frontal secretory gland (*fg*) is very similar to that in *Achtheres*, and fills the entire front of the head above the esophagus. The median center of the maxillipedal gland (*mp*) may be seen between the dorsal surface of the stomach and the adjacent body wall; the lateral centers appear in other sections. These excretory glands are much reduced in such dwarfed males, and although the centers are fairly distinct the ducts can not be discerned. There is about the same difference between the infra- and supra-esophageal ganglia as was found in *Achtheres*. The supra ganglion (*sg*) is oval in section and sends out a good-sized nerve to the frontal margin. Another nerve extends from the posterior end to the frontal gland, the anterior end of the stomach, and the median center of the maxillipedal gland. The infra ganglion (*ig*) is much larger and very irregular in outline, and supplies the lower lip, the various mouth-parts, and the reproductive organs. These latter consist of a pair of testes with their deferent ducts, a spermatophore receptacle, and the duct which leads from the latter to the external surface. The testes (*t*) are relatively large and ellipsoidal in form, and instead of being located between the stomach and the dorsal body wall, as in *Achtheres*, they are placed below and on either side of the stomach and intestine, nearly in the center of the posterior part of the body. At the posterior end of the testis may be seen the spermatogonia (*stg*) with their large, spheroidal nuclei; passing forward we find the primary and secondary spermatocytes (*stc*) considerably reduced in size, and finally at about the center of the testis, the spermatozoa (*sp*). These gradually arrange themselves with their long diameter parallel to the axis of the testis. Toward the forward end where the testis narrows, the spermatozoa are bunched together and pass in this form out into the deferent duct. Around the anterior end of the testis and lining the walls of the deferent duct are large pear-shaped gland cells (*gc*), which secrete the material that forms the outer covering of the spermatophores. Around the anterior end of the testis these cells all have their large ends outward and their small ends inward, thus bringing about the necessary reduction in diameter at the opening of the deferent duct. Along the walls of the latter they are more irregular in shape, and are arranged in no definite order. The deferent duct bends completely around as soon as it leaves the testis and passes back just beneath the latter to its posterior end. There it again turns completely around and passes forward, opening to the surface at the tip of the genital process just behind the second maxillae. In this last section, which may be called the spermatophore receptacle, the gland cells entirely disappear from the walls, and the bunched spermatozoa, already surrounded by the cement substance, are molded into spermatophores (*sph*).

Color (preserved material), a dirty white.

Total length, 1.15 mm. Greatest width, 0.65 mm.

(*rugosus*, rough, alluding to the body and neck of the female.)

Remarks.—This species was first described by Krøyer in 1837, and later by Baird (1850), van Beneden (1851), and T. Scott (1900).

The specimen described and figured by Baird does not agree with the others and certainly was not the present species. Moreover, it was obtained from a different host, "*Gadus cellarius;*" the other descriptions agree and the specimens were all obtained from the same host. Scott says of it:

> I find also on the codfish what appears to be the same species of *Anchorella*. It is evident, however, that these organisms, so far as the British species are concerned, require a more careful study than they have yet received (1900, p. 176).

After such a study of the specimens in the United States National Museum it has been deemed best to make this species the type of a new genus, which resembles *Clavella* in general characters, but differs in many details.

CLAVELLISA, new genus.

Generic characters of female.—Cephalothorax much longer than the trunk, slender and often wrinkled, attached to the center of the dorsal surface of the trunk; head distinctly separated from the neck, slightly enlarged and covered with a dorsal carapace; trunk wider than long, somewhat flattened dorso-ventrally, and destitute of abdomen, anal laminae, genital, or posterior processes; egg strings short and wide, sometimes at an angle with the body.

First antennae exceptionally large and heavily armed, the spines often flattened like a knife blade and projecting far in front of the head. Second antennae biramose, the two rami at right angles to the basal portion and turned across the frontal margin. First maxillae usually bipartite, the palp with a single seta; second maxillae short and laminate; maxillipeds of the usual pattern.

Generic characters of male.—General form ovoid, the anterior portion covered with a carapace; body folded upon itself and thoroughly fused without any distinction of parts or segmentation; mouth tube, appendages, and genital process on the ventral surface at different angles with the body axis, and not crowded together, as in *Clavellodes*. First antennae three-jointed, basal joint much larger than the others; second antennae biramose, the rami cylindrical and unjointed; first maxillae tripartite; second maxillae and maxillipeds long and armed with strong claws; genital opening at the tip of a prominent knob behind the second maxillae.

Type.—*Clavellisa spinosa*, new species.

(*Clavellisa*, *Clavella* and ἴσος, similar in appearance.)

Remarks.—This is another new genus and includes two new species and three that have been heretofore included in the genus *Anchorella*. The first and most noticeable peculiarity of the genus is the attachment of the cephalothorax to the dorsal surface of the trunk, at about its center. Apparently it has no connection whatever with the second maxillae; in other words the second maxillae have migrated backward the whole length of the neck, and have then moved along the outer surface of the trunk until they are some distance away from the base of the neck.

Then the first antennae are much enlarged, have become rigid, and project straight forward, being armed, at least in one species, with large and wicked spines, totally unlike anything known in the entire family of Lernaeopodidae. In the male while there has been a folding and complete fusion of the body, it has not been carried as far as in *Clavella* and *Clavellodes*. The posterior portion of the body stands at an angle of about 45° with the anterior portion, and the genital process and appendages stand at the same angle.

TABLE OF SPECIES.

1. First antennae armed with stout spines, rigid, and projecting in front of the head; egg strings at an angle of 45° with the trunk axis..*spinosa*, new species, p. 694.
1. First antennae well armed, but flexible and not projecting in front of the second pair; egg strings parallel with trunk axis.............................. 2.
2. The trunk spherical or ovoid and without any posterior invagination at the center. 3.
2. The trunk flattened dorso-ventrally and emarginate posteriorly at the center.... 4.
3. Cephalothorax more than three times the length of the trunk; the latter spherical ....*scombri* (Kurz), 1877.
3. Cephalothorax only one-half longer than the trunk; the latter ovoid. *ovalis* (Krøyer), 1837, p. 696.
4. Cephalothorax twice the length of the trunk; the latter subrectangular in outline..*emarginata* (Krøyer), 1837.
4. Cephalothorax only one-third longer than the trunk; the latter heart-shaped. *cordata*, new species, p. 697.

CLAVELLISA SPINOSA, new species.

Plate 50, figs. 188 and 189; plate 52, fig. 200.

Host and record of specimens.—Eight specimens, including both sexes, were obtained from the gill rakers of the menhaden, *Brevoortia tyrannus*, at Beaufort, North Carolina, August, 1905. They have received Cat. No. 39556, U.S.N.M. One female was obtained by Doctor Linton from the same host and locality, and has received Cat. No. 39612, U.S.N.M. Five females and two males were taken by Dr. M. T. Thompson from the same host at Woods Hole, Massachusetts, August 6, 1901, and have received Cat. No. 39803, U.S.N.M. A single female from the first Beaufort lot, carrying an attached male on the side of the neck, is made the type of the new species, and is given Cat. No. 43547, U.S.N.M.

Specific characters of female.—Cephalothorax proportionally slender, from three to five times the length of the trunk, tapering from the trunk toward the head, and turned back so that its dorsal surface rests against that of the trunk; head not enlarged, but strongly narrowed anteriorly, where it terminates in three projections made up of the antennae and the mouth tube, covered dorsally with a fairly distinct carapace; neck usually profusely wrinkled; trunk nearly twice as wide as long, flattened on the dorsal surface, and kidney- or bean-shaped, the arms extending from the eye of the bean; the swollen sides of the trunk are filled with the convolutions of the oviducts and increase in size and convexity with the maturing of the eggs; no abdomen, anal laminae, genital or posterior processes; egg strings ellipsoid or kidney-shaped and attached not by one end, but near the middle of one side, causing them to stand at an angle of

45° with the trunk axis; eggs arranged in 7 or 8 longitudinal rows, about 50 in each string.

First antennae imperfectly three-jointed, projecting far in front of the second pair, relatively very large, and with a wicked armature. At the tip are four stout ventral spines and two dorsal ones, the latter as long as the antennae themselves and usually surrounded by a wide membranous flange; the second joint also carries a pair of stout spines on its dorsal surface. This armature is totally different from anything found in the entire family and must be quite effective for piercing the skin of the host. Second antennae biramose, the terminal joints turned squarely across the frontal margin at right angles to the basal joint, the exopod (ventral) smaller than the endopod (dorsal), each bluntly rounded and armed with a single short and stout spine. Mandible long and slender, with a narrow neck, the tip enlarged and armed with eight well-rounded teeth. First maxillae tipped with three stout spines, the outer of which is sometimes surrounded with a membranous flange; palp armed with a single spine. Second maxillae short and stout, laminate, not tapering, united only at the tips, and furnished there with a long and rather slender club-shaped bulla, the pedicel of which is enlarged and forked at the apex, where it incloses a small and solid sphere. Maxillipeds with a stout basal joint and a long and slender terminal claw, with no accessory armature.

Color, trunk transparent cartilage color; oviducts and eggs white; cephalothorax usually black or blackish from the contents of the digestive tube.

Cephalothorax and second maxillae, 1.50 mm. long, 0.15 mm. wide. Trunk, 0.50 mm. long, 0.85 mm. wide. Egg strings, 0.60 mm. long, 0.35 mm. wide.

Specific characters of male.—Body completely folded upon itself and so thoroughly fused that there are no traces of parts or segmentation; egg-shaped, with the head at the pointed end, and the appendages and genital process on one side of the egg; head covered with a dorsal carapace, which extends back of the second maxillae. First antennae three-jointed, tipped with stout setae; second antennae similar to those of the female, but not bent, the exopod larger than the endopod, both rami unsegmented and tipped with two small spines; mandibles and first maxillae like those of the female; second maxillae long, with a slender second joint and rather a weak terminal claw; maxillipeds with a large and stout basal joint and a slender terminal claw, armed with a row of minute teeth along its inner margin.

Color, a uniform yellowish-white.

Total length, 0.25 mm. Greatest width, 0.125 mm.

(*spinosus*, covered with spines, alluding to the first antennae.)

Remarks.—This species is fairly common on the menhaden, but only one or two specimens are found upon the same fish. It can be at once distinguished by its minute size, by the long and slender cephalothorax, and by the kidney-shaped egg strings, carried at an angle with the trunk axis. Different specimens vary considerably in the size and armature of the antennae, as well as in the angle at which the egg strings are carried. The males correspond more closely than the females, and there is enough conformity among the latter to insure the validity of the species.

CLAVELLISA OVALIS (Krøyer).

Anchorella ovalis Krøyer, 1837, p. 289, pl. 3, fig. 6*a* and *b*.

Host and record of specimens.—Krøyer found a single specimen of this species, without egg strings, on the gills of *Trigla gurnardus;* no locality given.

Remarks.—From Krøyer's description and figure it is certain that he had a Lernaeopod very similar to the "*Anchorella emarginata*" which he had just described. In distinguishing the two he says that in *A. ovalis* the trunk is thick and egg-shaped, the cephalothorax is one and a half times as long as the trunk and of medium thickness, the head is short and broad, but thick. His figure shows that the cephalothorax is attached to the center of the dorsal surface of the trunk, while the second maxillae are attached to the ventral surface some distance from the base of the neck.

He did not describe the appendages at all, but the above facts are enough to locate the species in the present genus.

Beneden afterwards (1870, p. 31, pl. 2, fig. 8) figured a parasite which he referred to this species, but which certainly did not belong here as can be seen from a comparison of Krøyer's and Beneden's figures. Beneden's species had a short and thickset cephalothorax attached in the usual way to the anterior end of the trunk, while the second maxillae were on the neck some distance above where it joins the trunk.

Earlier in the same paper (p. 270) Krøyer described a species which he named "*Lernaeopoda obesa.*" He had but a single specimen and had forgotten the host, but thought it was "*Squalus acanthius* Linn." In 1869 Olsson found the same parasite upon the gill arches of the common gurnard, *Trigla gurnardus,* and transposed it to the genus *Brachiella.* It is this species *obesa* rather than the species *ovalis* which Beneden and Scott have found upon the gurnard (see p. 701). It belongs in the genus *Brachiella* where Olsson placed it, but Krøyer's *ovalis* just as certainly belongs here in the genus *Clavellisa.*

CLAVELLISA CORDATA, new species.

Plate 26, fig. E; plate 50, fig. 187; plate 52, figs. 201 to 208.

Host and record of specimens.—Twelve females and four males were obtained by Vinal N. Edwards from the gills of the hickory shad, *Pomolobus mediocris*, at Woods Hole, October 30, 1903. They have received Cat. No. 39566, U.S.N.M. and become paratypes of the new species.

A single female with attached male was taken from this lot and made the species type, with Cat. No. 43539, U.S.N.M.

A second lot of 20 specimens, including both sexes, was obtained from a single hickory shad at the same locality in September, 1902; they have received Cat. No. 39579, U.S.N.M.

A third lot of 10 specimens, including both sexes, was taken from the gills of the alewife, *Pomolobus pseudoharengus* at Woods Hole, October 5, 1887, and has received Cat. No. 43534, U.S.N.M.

Two lots, containing three females each, were obtained from the gills of young shad, *Pomolobus mediocris*, taken in the pound at Woods Hole, July 8, 1875, by A. E. Verrill; they have received, respectively, Cat. Nos. 39622 and 38026, U.S.N.M.

Three females were obtained by Dr. M. T. Thompson from the gills of the alewife at Woods Hole, August 10, 1901; they have received Cat. No. 39595, U.S.N.M.

Specific characters of female.—Cephalothorax longer than the trunk, slender, cylindrical, and about the same diameter throughout; head not enlarged, but narrowed anteriorly and covered with a dorsal carapace; trunk heart-shaped, of the same width and length, flattened dorso-ventrally, narrowed anteriorly, and with a median posterior sinus; cephalothorax attached to the dorsal surface of the trunk a little in front of the center; egg strings cylindrical and about as long as the trunk; eggs small, in 8 longitudinal rows, about 20 eggs in a row.

First antennae stout, indistinctly three-jointed, with a tuft of small setae at the tip; second antennae also stout, the terminal biramose portion swollen, turned at right angles to the basal portion and bluntly rounded; exopod one-jointed and armed with a single stout spine, endopod indistinctly two-jointed, with two minute terminal spines. Mandibles with a narrowed neck and a widened blade, armed with five large curved and bluntly rounded teeth. First maxillae with two terminal setae, the palp with a single seta; second maxillae attached at the anterior end of the trunk some distance from the base of the neck, short, cylindrical, not tapering, squarely truncated at the tips, where they are united by their inner corners; bulla long, slender, and club-shaped.

Maxillipeds with a stout basal joint and a short and stout terminal claw, curved at the tip, where it carries on the inner margin a long accessory claw, behind which is a row of saw teeth.

Color, a uniform yellowish-white, the contents of the stomach and intestine dark brownish-black; egg strings orange yellow.

Cephalothorax, 4 mm. long, 0.50 mm. wide. Trunk 3 mm. long, 3 mm. wide at the posterior end. Egg strings 3.5 mm. long, 0.8 mm. wide.

Specific characters of male.—Body folded on itself in the same way as in *spinosa,* swollen, with no distinction of parts or segmentation; a dorsal carapace on the head; genital process larger than in *spinosa;* no anal laminae. First antennae three-jointed and well armed with setae; second antennae biramose, the exopod two-jointed and tipped with a tuft of setae, the endopod slender, ellipsoidal, and unarmed. Mouth tube long and prominent, projecting its entire length in front of the carapace.

First maxillae much shorter than in the female and projecting just to the tip of the mouth tube; second maxillae rather slender, the basal joint long and narrow. Maxillipeds with a stout and thick basal joint and a terminal claw like that of the female.

Color, a uniform yellowish-white.

Total length, 0.30 mm. Greatest width, 0.20 mm.

(*cordatus,* heart-shaped, alluding to the trunk.)

Remarks.—This species is fairly common on the two kinds of herring mentioned. It may be recognized by the heart-shaped trunk with the long and slender cephalothorax attached to its dorsal surface. If there is need of any further distinction from *spinosa* it may be found in the egg strings, which are here attached by one end, are parallel with the trunk axis, or are curved like parentheses marks. In the ripening ovary of this species the thread or filament connected with the oocyte is much longer than in *Achtheres,* and contains often as many as 20 cells (fig. 187, pl. 50).

Genus BRACHIELLA Cuvier.

Generic characters of female.—Cephalothorax elongate and cylindrical, flexed more or less backward, often against the dorsal surface of the trunk; head usually enlarged and covered by a distinct dorsal carapace; trunk swollen, flattened dorso-ventrally, and in the larger species (10 to 25 mm.) with two rows of pits or grooves or knobs on the dorsal and ventral surfaces; two or four paired posterior processes and an unpaired genital process; no abdomen or anal laminae; egg strings long and slender.

First antennae two to four (usually three) jointed, basal joint more or less swollen; second antennae biramose, the exopod (ventral) two-jointed; first maxillae tripartite, palp with one or two setae; second maxillae separate to the tips where they are jointed to an ordinary bulla; sometimes fused; maxillipeds with a stout basal joint and a long terminal claw.

Generic characters of male.—Cephalothorax inclined more or less to the trunk, from which it is separated by a well-defined constriction and often by a short neck; head covered by a dorsal carapace which varies considerably in size; trunk straight, spindle-shaped, and much narrower than the cephalothorax; small anal laminae sometimes parallel with the trunk axis, sometimes at right angles to it; often with a large unpaired (genital) process between the second maxillae. First antennae three-jointed, about the same length as the second pair; the latter biramose, both rami one-jointed, the exopod (ventral) sometimes with two joints; first maxillae three or four partite; second maxillae and maxillipeds close together and about the same size, both provided with stout curved claws.

Type.—*Brachiella thynni* Cuvier.

(*Brachiella*, *βραχίων*, arm, with diminutive ending.)

Remarks.—This genus, like *Clavella*, has received many species which ought never to have been assigned to it. For a long time the distinction between the two genera consisted simply in the separation or fusion of the second maxillae. If they were fused the species was placed in the genus *Clavella*; if they were separate it was referred to the genus *Brachiella*, irrespective of its other morphological peculiarities. Consequently, we find here also many species which must be transferred to other genera, or for which new genera must be created. The list which follows includes such species. There is rather more dissimilarity amongst the males than in the other genera but they agree very well in all essential characters. Probably when the species, and especially the males, become better known it will be necessary to separate some more of them and establish other new genera. Even the data already known with reference to such species as *concava* and *lophii* make it practically certain that they must eventually be placed elsewhere. But until we can get the necessary data it is better to keep them here where they were originally placed.

Synonyms.—*Brachiella anserina* Wilson, 1908, p. 467, differs in so many and so important particulars from the *Brachiella* here established that it has been made the type of a new genus, *Probrachiella* (see p. 716).

Brachiella antarctica Quidor, 1906, p. 30, pl. 3, figs. 45 to 48, has no posterior processes, the exopod of the second antennae is unsegmented, the second maxillae are entirely separate, and the male differs so much from *Brachiella* that it has been made the type of a new genus, *Eubrachiella* (see p. 716).

B. appendiculata Steenstrup and Lutken, 1861, p. 419, and *B. appendiculosa* Bassett-Smith, 1898, p. 14, are both synonyms of *Thysanote appendiculata* (see p. 651).

B. dentata Wilson, 1912, p. 97, is proved by the structure of the male to belong to the genus *Charopinus* (see p. 654).

B. fimbriata Heller, 1865, p. 240, belongs to the genus *Thysanote* (see p. 651).

B. gaini Quidor, 1912, p. 211, is placed with *B. antarctica* in the new genus *Eubrachiella* (see p. 716).

B. impudica Nordmann, 1832, p. 92, is proved by the structure of the male as well as the female to be distinct from *Brachiella* and is made the type of the new genus *Epibrachiella* (see p. 715).

B. inconcinna, minuta, and *ramosa* were simply named by Richiardi (1880, p. 151) and have never been described or figured.

B. insidiosa Heller, 1865, p. 239, is referred to the new genus *Parabrachiella* (see p. 713).

B. lobiventris Heller, 1865, p. 241, belongs to the genus *Thysanote* (see p. 651).

B. lophii Milne Edwards, 1840, p. 514, was briefly described and well figured, but has never been seen by any other investigator, although it is included in two or three lists on the authority of Milne Edwards. The description and figures given by the latter are enough to indicate fairly well that the species does not belong to *Brachiella*, nor indeed to any of the other genera in the family.

The size of the creature (cephalothorax and second maxillae 20 mm.; trunk and posterior processes 16 mm.), the structure of the second antennae, first maxillae (unipartite), and maxillipeds, and the peculiar shape and attachment of the posterior processes show little affinity with any of the genus types here presented.

But the male is unknown and the data are not sufficient to enable us to erect a new genus, so the best that can be done is to leave it where Milne Edwards placed it and wait for further details.

B. malleus Nordmann, 1832, p. 95, is proved by the structure of the male, as well as certain characters of the female, to belong to the genus *Charopinus* (see. p. 654).

B. multifimbriata Bassett-Smith, 1898, p. 96, is shown by the structure of the male to be distinct from *Brachiella*, and as the female is also peculiar it is made the type of a new genus, *Thysanotella* (see p. 652).

B. neglecta Richiardi, 1880, p. 151, was another mere name, but it was afterwards briefly described and figured by Brian (1898. p. 24, pl. 4, fig. 29). He, however, mentions and portrays a pair of tubercles, each armed with a claw, on the posterior margin of the trunk. Nothing like them is known anywhere among the Lernaeopods, and if correct the parasite would at least become a distinct genus. But it has not yet been well enough described to be located anywhere with satisfaction.

B. obesa (Krøyer), 1837, p. 270, was described as belonging to the genus *Lernaeopoda.* Krøyer had but a single specimen and had forgotten on what host it was found, but said he thought it was "*Squalus acanthius* Linn." Olsson found the same parasite in the throat of *Trigla gurnardus,* and on account of the elongate cephalothorax and the removal of the second maxillae some distance behind the other mouth parts, he transferred it to the genus *Brachiella* (1869, p. 42), where it rightly belongs

In 1870 P. J. van Beneden reported (p. 10) the same species from "*Spinax acanthius* L." on the coast of Belgium. He also reported (p. 31), from the gills of *Trigla gurnardus,* a species which he called "*Anchorella ovalis* Krøyer," and of which he gave a figure (pl. 2, fig. 8). But this figure shows no similarity whatever to Krøyer's *ovalis,* while it does resemble in all essential particulars his *Lernaeopoda obesa.*

T. Scott described (1901, p. 133) from the gills of *Trigla gurnardus* on the Scottish coast a parasite which he referred to Krøyer's *A. ovalis,* basing his judgment upon Beneden's figure. But as Beneden was wrong, so of course Scott was misled, and the species he had was not *ovalis* at all, but *obesa.* The excellent figures given by Scott (pl. 7, figs. 30 to 35) leave no doubt that he was really dealing with the same species examined by Krøyer and Olsson. But it belongs in the genus *Brachiella* where Olsson placed it, and is here restored to that genus.

Richiardi in the list already mentioned (1880, p. 151) named a parasite which he obtained from "*Trigla corax*" in the Mediterranean, *Brachiella obesa,* but gave no description or figures. This was probably the same as Krøyer's species, but even if it was not Krøyer's name holds precedence.

B. oblonga Valle, 1880, p. 76, is another mere name and has never been described or figured.

B. ovalis (Beneden) Scott, 1901, p. 133, as shown above, is a synonym of *obesa.*

B. parkeri Thomson, 1889, p. 374, can not belong to any of the genera previously described and is made the type of the new genus *Thomsonella,* closely related to *Brianella* (see p. 649).

B. pastinacae Beneden, 1851, p. 118, is a synonym of *Charopinus bicaudatus* (see p. 656).

B. pernettiana (Blainville), 1822, p. 439, was originally described and figured as a "Lernaean" by Pernetti (1770, vol. 1, pl. 1, figs. 5, 6).

Blainville included it in his new genus *Lernaeomyzon* and gave a brief description. Cuvier (1830, p. 257) referred it to the genus

Brachiella, but added nothing further in the way of description, and thus we are left with insufficient data to locate it intelligently.

B. rostrata Krøyer, 1837, p. 207, differs so radically in both sexes from *Brachiella* that it is made the type of a new genus, *Parabrachiella* (see p. 714).

There are thus five species which are mere names, three which can not be satisfactorily located, and 16 which must be transferred to other genera, including six which become new genus types.

TABLE OF SPECIES.

1. Only two posterior processes, dorsal to the egg strings .... 2.
1. Only two posterior processes, ventral to the egg strings .... 3.
1. Four posterior processes, two dorsal and two ventral .... 7.
2. Posterior processes pear-shaped with a narrow pedicel; first maxillae unipartite; both rami of second antennae unsegmented .... *lophii* Milne-Edwards, 1840.
3. Posterior processes cylindrical, widely separated; first maxillae tripartite; exopod (ventral) of second antennae two-jointed .... *concava* Wilson, 1913, p. 703.
3. Trunk ovoid, considerably longer than wide; posterior processes minute and conical; genital process present .... 4.
3. Trunk ovoid, about the same length and width; posterior processes larger; no genital process .... 5.
3. Trunk swollen, wider than long; posterior processes large and laminate; genital process rudimentary .... 6.
4. Second maxillae as long as the cephalothorax, cylindrical and slender; first antennae four-jointed and slender .... *bispinosa* Nordmann, 1832.
4. Second maxillae half as long as the cephalothorax, cylindrical and slender; first antennae three-jointed and stout .... *exigua* Brian, 1906.
4. Second maxillae half as long as the cephalothorax, stout and flattened; first antennae three-jointed and slender; posterior processes laminate. *mitrata*, new species, p. 709.
5. Posterior processes cylindrical, bluntly rounded; second maxillae short and stout; egg strings as long as the trunk .... *pinguis*, new species, p. 710.
5. Posterior processes conical, with an acute point; second maxillae long and slender; egg strings twice the length of the trunk .... *nitida*, new species, p. 711.
6. Trunk irregular, covered with lobes and processes, emarginate posteriorly; first antennae short and two-jointed .... *triglae* Claus, 1860.
6. Trunk smooth and regular, rounded posteriorly; first antennae four-jointed, swollen .... *obesa* (Krøyer), 1837, p. 701.
7. The four posterior processes about the same length .... 8.
7. Ventral posterior processes distinctly longer than dorsal .... 11.
7. Dorsal posterior processes distinctly longer than ventral .... 12.
8. Size large (10 mm.); head enlarged and covered with a dorsal carapace; second maxillae separate to their tips .... 9.
8. Size small (5 mm.); head not enlarged, no carapace; second maxillae fused for their entire length .... 10.
9. Genital process half as long as posterior processes; maxillipeds huge, each nearly as large as the entire head; second maxillae smooth...*chevreuxii* Beneden, 1891.
9. Genital process minute; maxillipeds of normal size; first antennae two-jointed; second maxillae much wrinkled .... *appendiculosa* (Krøyer), 1863, p. 712.
10. Ventral processes close together, dorsal ones far apart; genital process present; second maxillae smooth .... *appendiculata* (Krøyer), 1863.
10. Ventral processes close together, dorsal ones far apart; genital process present; second maxillae wrinkled .... *hostilis* Heller, 1865.

10. Ventral and dorsal processes the same distance apart; no genital process; second maxillae smooth.......................................*sciaenophila* Heller, 1865.
11. Trunk smooth; second maxillae much longer than cephalothorax; first antennae three-jointed.......................................*gracilis* Wilson, 1908, p. 712.
11. Trunk smooth; second maxillae much shorter than cephalothorax; first antennae three-jointed; genital process long and club-shaped.*gulosa*, new species, p. 705.
11. Trunk smooth; second maxillae very short; first antennae three-jointed; genital process long and cylindrical.....................*merluccii* Bassett-Smith, 1896.
11. Trunk with two rows of pits or grooves on the dorsal and ventral surfaces; second maxillae short; first antennae four-jointed; no genital process.
elegans Richiardi, 1880, p. 707.
12. Trunk wider than long; dorsal processes abruptly curved near their tips.
chavesii Beneden, 1891.
12. Trunk longer than wide; dorsal processes straight; two rows of pits on the dorsal and ventral surfaces of the trunk....................*thynni* Cuvier, 1830, p. 703.

BRACHIELLA CONCAVA Wilson.

Brachiella concava Wilson, 1913, p. 262, pl. 51.

Host and record of specimens.—A single female with egg strings was taken from the gill arch of a sting ray, *Dasyatis hastata,* at Montego Bay, Jamaica, August 10, 1910. This was made the species type and received Cat. No. 42286, U.S.N.M.

Remarks.—This species was fully described and figured in the reference above given. It is not common, but may be recognized by the size and shape of the posterior processes and the absence of a genital process. But these posterior processes are dorsal and not ventral, and are only found in one other species, *lophii,* which probably does not belong to the present genus, as already stated (p. 700). That throws the burden of proof on the present species if it is to remain in the genus; but this can not be decided fully until the male is found. When that occurs it is very possible that the species will be transferred to the genus *Charopinus.*

BRACHIELLA THYNNI Cuvier.

Plate 25, fig. C; plate 53, figs. 209 to 215.

Brachiella thynni Cuvier, 1830, p. 257, pl. 15, fig. 5.
Thynnicola ziegleri Miculicich, 1904, p. 47.

Host and record of specimens.—A single female with egg strings was taken from the gills of a tunny fish at Cornwall, England, and sent to the United States National Museum by Rev. A. M. Norman. It was numbered 8342, U.S.N.M. Twenty-five females and four males were obtained from the gills of *Thynnus thynnus* at Bakar, Croatia, Hungary, by Prof. S. Brusina. They have received Cat. No. 43458, U.S.N.M.

Specific characters of female.—Cephalothorax as long as the trunk, cylindrical, and usually bent slightly backward; head little if any enlarged, but covered with a distinct dorsal carapace; neck the same diameter throughout, and separated from the trunk by a well-defined groove; trunk ovate, flattened dorso-ventrally, and in older specimens much wrinkled; at least two segmentations plainly indicated by breaks in the ventral musculature, by ventral grooves, and by lateral indentations; two pairs of posterior processes, one dorsal, the other ventral, the latter usually half the diameter and length of the former, and closer together; both pairs curved like parentheses marks, and the bases of the dorsal pair curved around inside the point of attachment as two small knobs, side by side on the median line; no genital process; egg strings between the two pairs of processes and a little longer than the dorsal pair; eggs minute, arranged in 10 or 12 longitudinal rows, fully 75 eggs in the longest rows.

First antennae stout, three-jointed, unarmed; second antennae turned down across the frontal margin, the exopod minute, degenerate, and nearly fused with the endopod. First maxillae large and stout, tripartite, each ramus swollen at the base and tipped with a single spine; palp also swollen, turned at right angles to the rest of the appendage and tipped with a single spine.

Second maxillae small and short, and free to the very tips, each maxilla ending in a semilunar attachment disk; the edges of the disks are grown together, but apparently they do not form a single bulla. At the base of each maxilla on the dorsal surface is an oblong ridge or projection, which runs lengthwise of the appendage and contains the maxillary gland.

Maxillipeds widely separated, so that all the other mouth parts can be seen between them in ventral view; basal joint triangular and much longer than wide; terminal claw slender, and tipped with a single spine which shuts into a depression on the inner margin of the basal joint; no accessory spine.

Color (preserved material), a rich golden yellow.

Cephalothorax, 6 mm. long, 1 mm. wide. Trunk, 6 mm. long, 3 mm. wide. Dorsal posterior processes, 8 mm. long. Egg strings, 9 mm. long.

Specific characters of male.—Head at an angle of 45° with the body axis and covered with a well-defined carapace; posterior cephalothorax contracted into a narrow, wasplike waist, where it joins the trunk; the latter ovate, with a pair of slender conical anal laminae at the pointed posterior end, on the dorsal surface. Ventral to the anal laminae is the rounded genital process, which is a little longer and much thicker than the laminae.

First antennae stout and three-jointed; second antennae biramose, the endopod tipped with a single spine, the exopod with a minute chela. Mouth tube large and in line with the axis of the head; first maxillae short and wide, like a hand with three fingers and a thumb, each tipped with a single spine. Second maxillae large, widely separated, each tipped with a long curved claw. Maxillipeds close together, the basal joint much longer than wide, the terminal claw sharply bent.

Color the same as that of the female.

Total length, 2.25 mm. Greatest diameter, 0.5 mm.

(*thynni,* the generic name of the host.)

Remarks.—This species is one of the largest of the genus, and was first described by Cuvier, who made it the type-species of his new genus *Brachiella.* Since then it has been described or noticed by almost every writer on the parasitic copepods, and always under the same name, with one exception. Miculicich, supposing it to be new, gave a long account of it with text figures [1] and named it *Thynnicola ziegleri.* This mistake he himself corrected in March, 1905, in the same periodical. But in spite of the fact that it is so universally known, there are still several things in connection with its structure that need either correction or further description. For this reason the above account has been given, with such figures as seemed necessary. The facts here established are:

1. The body of the female is as fully segmented as that of *Achtheres,* and the segmentation is similarly indicated.
2. The head is covered with a well-defined dorsal carapace.
3. The neck is separated from the trunk by a groove behind the second maxillae.
4. There is no genital process.
5. The second antennae are biramose, the exopod (ventral ramus) being rudimentary.
6. The first maxillae have a palp at right angles to the body of the appendage.
7. The maxillipeds are widely separated.

BRACHIELLA GULOSA, new species.

Plate 53, figs. 216 to 220; plate 54, figs. 221 to 224.

Host and record of specimens.—Three lots of this parasite were obtained by Dr. Hugh M. Smith from the under surface of the operculum of the channel bass, *Scienops ocellatus,* from the Center Market at Washington, District of Columbia. The first lot, ten females and two males, were captured off Elizabeth City, New Jersey, and were given Cat. No. 43588, U.S.N.M. The second lot, eighteen females and four males, were captured off the North Carolina coast, and have received Cat. No. 39578, U.S.N.M. The third lot, five females and one male, were captured near Morehead City, North Carolina, and bear Cat. No. 39580, U.S.N.M. A single female with attached male has been taken from the first lot and given Cat. No. 43585, U.S.N.M., as the type of the new species. Ten females and one male were taken off New York City, September 1, 1901, by Mr. Blackford; they have received Cat. No. 39581, U.S.N.M. Three females were taken at Woods Hole, Massachusetts, by the late Dr. M. T. Thompson, which have been given Cat. No. 39591, U.S.N.M. Seven females and one male were taken off the North Carolina coast, and have received Cat. No. 39573, U.S.N.M. The host is the same for all these specimens, the channel bass, *Scienops ocellatus*.

---

[1] Zool. Anz. for Sept., 1904.

Specific characters of female.—Cephalothorax stout, cylindrical, and considerably longer than the trunk; head enlarged and covered with a dark brown carapace; neck and second maxillae curved like a sickle; trunk anteriorly narrowed into a short neck where it joins the cephalothorax, posteriorly inflated into a sphere, which is flattened dorso-ventrally; four posterior processes, two dorsal and two ventral, and a genital process between the two latter, short and club-shaped; the ventral posterior processes are straight, parallel, and longer than the dorsal pair, which arise a little in front of the posterior margin and are curved like parentheses marks; between the two pairs are the egg strings, which are from one and a half to two and a half times the length of the processes, and about twice their diameter; eggs small, in from 10 to 12 longitudinal rows, about 50 eggs in a row.

First antennae somewhat swollen at the base and three-jointed; second antennae biramose and turned down across the frontal margin, the endopod (dorsal ramus) large, bluntly rounded, one-jointed, and unarmed, the exopod (ventral ramus) comparatively minute, two-jointed, and terminated by a tuft of small setae.

Mouth-tube short, broad at the base, and hardly reaching the second antennae; first maxillae bipartite, palp one-jointed and tipped with a single spine. Second maxillae short, slender, and entirely separate as far as the bulla, which is in the shape of a flattened sphere. The glands at the bases of these maxillae stand out as prominent knobs on either side of the neck.

Maxillipeds with a stout basal joint and a slender terminal claw which shuts down against a knob on the inner margin of the basal joint.

Color (preserved material), a light brownish-yellow.

Cephalothorax, 4.65 mm. long, 1 mm. wide. Trunk, 3.25 mm. long, 3.25 mm. wide, 2 mm. thick. Second maxillae, 1.50 mm. long. Posterior processes (ventral), 3 mm. long. Egg strings, 6 mm. long, 0.80 mm. wide.

Specific characters of male.—Head at an angle of 45° with the body axis, and covered with a distinct dorsal carapace; trunk with the first and second segments forming a narrow neck or waist, the posterior portion narrow ovate and ending in a pair of slender anal laminae, which are conical and at right angles to the trunk axis. First antennae slender and three-jointed; second antennae biramose, the endopod smoothly rounded, the exopod with a single spine at the outer corner. Mouth tube projecting its entire length in front of the anterior margin of the carapace in line with the head axis. First maxillae tripartite, palp tipped with a single spine; second maxillae considerably longer than the maxillipeds and tipped with powerful claws, which shut into a socket on the inner margin of the basal joint.

Maxillipeds short and stout and tipped with a strong claw; genital process distinctly visible between and partly behind the second maxillae, with a fringed or fluted tip.

Color, a whitish-yellow, lighter than the female.

Total length, 1.45 mm. Greatest width, 0.65 mm.

(*gulosus*, gluttonous.)

Remarks.—In the second lot of parasites mentioned there were three young females, one of them only 1 mm. long. These females had but a single pair of posterior processes, the ventral ones, but in the largest of the three another pair were just starting on the dorsal surface. Evidently, therefore, the ventral pair are formed first and the dorsal pair grow out later to supplement them. The general appearance, the arched neck, the distinct carapace, the knoblike protrusions of the maxillary glands, the short and slender second maxillae, and the arched dorsal processes distinguish this species from its nearest relatives.

BRACHIELLA ELEGANS Richiardi.

Plate 54, figs. 226 to 233; plate 55, fig. 234.

Brachiella elegans RICHIARDI, 1880, p. 151.—BRIAN, 1899, p. 8, fig. 4.

Host and record of specimens.—Five females and a male were obtained from the gill cavity of the amber jack, *Seriola lalandi*, at Woods Hole, Massachusetts, by the late Dr. M. T. Thompson, September 11, 1901.

They have received Cat. No. 39585, U.S.N.M., and since no other specimens are in existence at the present time they will serve as surrogate types of the species.

Specific characters of female.—Cephalothorax short, flattened dorsoventrally, and about the same length as the second maxillae; head somewhat enlarged and covered with a dorsal carapace; neck extremely short and passing insensibly into the trunk without any sign of demarcation; trunk elongate-triangular, widest across the posterior margin, which is almost squarely truncated; two pairs of posterior processes and a very short and well rounded genital process; ventral processes originating close to the midline, somewhat divergent and curved like parentheses marks, and three-fourths as long as the trunk; dorsal processes less than half the length of the ventral, originating close to the lateral margins, and widely divergent, in some cases even standing out at right angles to the trunk axis; egg strings about the same length as the trunk; eggs minute, in 6 or 7 longitudinal rows, about 30 eggs in a row.

First antennae four-jointed and tapered to a sharp point; second antennae biramose and bent down across the frontal margin, with the tips overlapping, the exopod (ventral ramus) much smaller than the endopod and indistinctly two-jointed, the endopod bilobed at the tip and armed with tiny spines.

Mouth tube broad at the base and long enough to overlap the tips of the second antennae. First maxillae bipartite, palp short and stout and armed with a single spine; second maxillae short, held at right angles to the body axis, and separate to the very tip, where they are attached to a large spherical bulla; maxillipeds with a stout basal joint and a slender terminal claw, armed on its inner margin near the tip with a secondary claw; these maxillipeds are attached so far forward that they almost reach to the frontal margin of the head.

Color (preserved material), a dark yellowish-brown.

Cephalothorax, 2.15 mm. long, 2 mm. wide, 1.25 mm. thick. Second maxillae, 1.75 mm. long. Ventral posterior processes, 4.33 mm. long. Egg strings, 5 mm. long.

Specific characters of male.—Cephalothorax small and separated from the trunk by a short waist; head covered with a dorsal carapace; trunk spindle-shaped, ending posteriorly in a long conical genital process; no anal laminae. First antennae four-jointed, joints subequal; second antennae biramose, endoped well rounded and armed with a single spine, exopod two-jointed and carrying a terminal tuft of setae. First maxillae with a two-parted tip and a small palp, armed with a single spine; second maxillae remarkably long and slender, over twice the length of the maxillipeds, the terminal claw slender, with a bluntly rounded pad at its base. Maxillipeds triangular and stout.

Color, the same as that of the female.

Total length, 1.35 mm. Greatest width, 0.35 mm.

(*elegans*, elegant or neat in appearance.)

Remarks.—This species was first named by Richiardi without any description or figure. It was afterwards identified by Brian, who described the female briefly and illustrated it with a single text figure. There is no doubt that these Woods Hole specimens belong to the same species that Brian figured; whether they are identical with Richiardi's named species can not, of course, be determined with certainty, but, since Brian's and Richiardi's specimens came from the same locality and host, there is a strong presumption that they are identical. A full description, with figures of both sexes, is here published for the first time.

The species closely resembles Heller's *B. insidiosa,* but differs in several important particulars, notably in the relative lengths of the two pairs of posterior processes, in the bilobed exopod of the second antennae, and in the position of the maxillipeds relative to the other mouth parts. The manuscript notes and sketches of Dr. M. T. Thompson have been of great service in making out the foregoing description.

BRACHIELLA MITRATA, new species.

Plate 54, fig. 225, plate 55, figs. 235 to 238.

Host and record of specimens.—Four adult females with egg strings were obtained by Dr. M. T. Thompson from the gills of the tilefish, *Lopholatilus chameleonticeps*, off Woods Hole, Massachusetts. Three of them are numbered 39594, U.S.N.M., and become paratypes; the fourth is made the type of the new species with the number 43559, U.S.N.M. A single rather poor specimen was obtained from the same host and locality by the present author, and has been numbered 39589, U.S.N.M.

Specific characters of female.—Cephalothorax short and very thick-set, and curved so that the axis of the head is at right angles to the trunk; a small dorsal carapace; groove separating the cephalothorax from the trunk obscure; trunk flattened dorso-ventrally, a little longer than wide, narrowed anteriorly and obliquely truncated (mitered) posteriorly; genital process on the ventral surface with a laminate posterior process on either side of it; egg strings cylindrical and as long as the entire parasite; eggs arranged in 6 longitudinal rows, about 25 in a row.

First antennae three-jointed, the basal joint much stouter than the others, the terminal joint tipped with three stout setae.

Second antennae turned down squarely across the frontal margin, the exopod (ventral) much smaller than the endopod, two-jointed and tipped with two short spines, the endopod rounded and unarmed. First maxillae slender and tipped with two long spines and a shorter one on the outer margin; palp short and stout and tipped with two spines. Second maxillae short, about the same diameter throughout, and separate to the very end, where they are joined to a short-stemmed, button-shaped bulla. Maxillipeds with a stout basal joint and a slender terminal claw, carrying an accessory spine on its inner margin near the tip.

Color (preserved material), a uniform brownish-yellow.

Total length, excluding egg strings, 6 mm. Cephalothorax 2.35 mm. long, 1.15 mm. wide. Second maxillae, 1.15 mm. long. Egg strings, 5 mm. long.

(*mitratus*, mitred or cut off diagonally, alluding to the posterior margin of the trunk.)

Male.—Unknown.

Remarks.—This species may be readily distinguished by the short and very thick neck, by the laminate posterior processes, and by the oblique truncation of the posterior part of the trunk. Here, again, the notes and sketches of Doctor Thompson have been of great value to the present author.

BRACHIELLA PINGUIS, new species.

Plate 55, figs. 239 to 244; plate 56, fig. 245.

Host and record of specimens.—Two adult females with egg strings, one young female and a male of this species were taken from the mouth of *Antimora viola* by the Bureau of Fisheries steamer *Albatross* in 1883 in the middle Atlantic south of Newfoundland. The better of the adult females has received Cat. No. 43540, U.S.N.M. and is made the species type; the others become paratypes and have been given Cat. No. 8341, U.S.N.M.

Specific characters of female.—Cephalothorax short, stocky, and cylindrical, not flattened; head enlarged a little and covered with a dorsal carapace; neck separated from the trunk dorsally by a well-defined groove; trunk ovate and smooth, without ridges or pits; two small posterior processes, close together on the ventral surface and about one-third as long as the egg strings; no genital process; egg strings stout and a little longer than the trunk; eggs small, arranged in twelve longitudinal rows, about 30 eggs in the longest rows. First antennae three-jointed and tapered regularly from base to tip; second antennae biramose and turned down squarely across the frontal margin, the exopod (ventral) very small and two-jointed. Mouth-tube wide and long, reaching the tips of the second antennae. First maxillae three-partite, the outer ramus much smaller than the others, the palp slender and tipped with a single seta. Second maxillae short and stocky, entirely separate to the tips in the young female, but more or less fused in the adults; bulla button-shaped.

Maxillipeds large and standing out prominently from the head, terminal claw stout, but only half the length of the basal joint, with an accessory claw on the inner margin.

Color (preserved material), a brownish-yellow.

Cephalothorax, 4.5 mm. long, 1 mm. wide. Trunk, 5 mm. long, without the posterior processes, 3.25 mm. wide, 3 mm. thick. Egg strings, 6. mm. long, 1.40 mm. in diameter.

Specific characters of male.—Cephalothorax at an angle of 45° with the axis of the trunk; head covered with a dorsal carapace; waist only a groove dorsally; trunk spindle-shaped and curved so that the conical anal laminae point ventrally.

First antennae slender and three-jointed; endopod of second pair bent over backward nearly at right angles, exopod ending in a chela. First maxillae like those of the female; second maxillae slender and very much longer than the maxillipeds; the latter triangular and rather small, but armed with a powerful claw.

Color (preserved material), yellowish-white.

Total length, 1.15 mm. Greatest diameter, 0.5 mm.

(*pinguis*, stocky or plump.)

Remarks.—This new species from one of the deep-water fishes may be recognized by its generally plump appearance, by the well defined dorsal carapace of the female, and by the two long and slender ventral processes. The peculiar characters in the male are the short and plump body, the small carapace, and the folding of the endopod of the second antennae.

BRACHIELLA NITIDA, new species.

Plate 56, figs. 246 to 248.

Host and record of specimens.—A single adult female with egg strings was obtained by the Bureau of Fisheries steamer *Albatross* from the mouth of *Albatrossia pectoralis*, at station 5015 in the northern Pacific in 1906. The specimen was perfectly preserved and easily determined to be a new species; it becomes the species type and has received Cat. No. 43584, U.S.N.M.

Specific characters of female.—Cephalothorax slender, flattened dorso-ventrally, and as long as the trunk; head enlarged and covered with a dorsal carapace; neck grooved in several places as though jointed; trunk a flattened sphere, with a smooth and evenly curved surface; two short posterior processes, close together on the ventral surface, and two-fifths as long as the trunk; egg strings over twice the length of the trunk and stout; eggs in 10 or 12 longitudinal rows, about 45 in the longest rows; no genital process. First antennae three-jointed, the basal joint much enlarged; second antennae biramose and turned down squarely across the frontal margin, the exopod two-jointed and reaching the tip of the endopod. Mouth tube short and narrow at the tip, not reaching the second antennae. First maxillae tripartite, the palp short and armed with a single seta.

Second maxillae slender, longer than the cephalothorax, and separate for their entire length; bulla small and mushroom-shaped.

Maxillipeds some distance behind the mouth-tube, rather slender, but standing out prominently from the head, with a short terminal claw, whose inner margin carries a series of minute teeth.

Color (preserved material), white.

Cephalothorax, 4 mm. long, 0.5 mm. wide. Trunk, 3.80 mm. long, 3.75 mm. wide, 2.5 mm. thick. Egg strings, 8 mm. long, 1 mm. in diameter.

(*nitidus*, dapper, neat.)

Male.—Unknown.

Remarks.—This is a peculiarly neat and clean looking species and may be recognized by the prominent maxillipeds, by the long and slender second maxillae, and by the exceptionally long egg strings. In the second antennae also there is a great difference in size between the two rami.

BRACHIELLA APPENDICULOSA (Krøyer).

Anchorella appendiculosa Krøyer, 1863, p. 306, pl. 16, fig. 6, *a* to *c*.

Host and record of specimens.—Krøyer took a single specimen of this species in April, 1853, at New Orleans, Louisiana, from the gills of a fish, "a *Corvina* or possibly a *Pagellus*, because I have no certain recollection of it and made no written notes."

Specific characters of female.—Cephalothorax longer than the trunk and made up of two parts, an elongated head covered with a brown carapace, and a thick, wrinkled neck; trunk thick and broad, obcordate in outline; four cylindrical posterior processes, the dorsal pair somewhat smaller than the ventral and farther apart, the ventral pair nearer together and longer than the trunk; genital process short and nearer the dorsal surface; egg strings large and a little longer than the processes.

Second antennae biramose, turned down across the frontal margin, the posterior or ventral ramus a little smaller and apparantly three-jointed. First antennae close to the mouth-tube near its base, two-jointed, the joints standing almost at a right angle to each other. Second maxillae three-fifths as long as the cephalothorax, situated at the posterior end of the neck, close to the trunk. Each maxilla is broad at the base and pointed toward the tip, where it is attached to a small, spherical bulla.

Maxillipeds large and prominent, the basal joint armed on the inner margin with roughened knobs and spines, the terminal claw with an accessory spine on the inner margin near the base.

Color, milk-white.

Total length, 8.75 mm. Cephalothorax, 4.85 mm. long. Trunk, 3.90 mm. long. Posterior processes, 4.25 mm. long.

(*appendiculosa*, with many small appendages).

Remarks.—This species has never been seen by any investigator other than Krøyer, but his description and figures are sufficient to establish the validity of the species, and since it was obtained at New Orleans it must be included in our North American forms.

There is good hope that it may be rediscovered when the fish of that locality are more carefully examined.

BRACHIELLA GRACILIS Wilson.

Brachiella gracilis Wilson, 1908, p. 464, pl. 77.

Host and record of specimens.—Both sexes and several developmental stages were taken by Dr. J. F. McClendon from the mouth of the white sea bass, *Cynoscion nobilis*, at La Jolla, California.

These were made the types of the species and were given Cat. No. 38577, U.S.N.M.

Remarks.—This species was fully described and figured in the reference given above. It may be recognized by the length and slenderness of the second maxillipeds, by the fact that they are held together for their entire length without being actually fused, and by the long genital process.

PARABRACHIELLA, new genus.

Generic characters of female.—Of large size (14 to 17 mm. long); cephalothorax of medium length and separated from the trunk by a well-defined groove, cylindrical and flexuose; a more or less distinct carapace on the head; trunk also cylindrical, somewhat flattened dorso-ventrally, without pits or grooves; one or two pairs of posterior processes and a minute genital process.

First antennae four-jointed; second antennae biramose, the exopod with two segments; first maxillae bipartite, the palp with two tiny spines; second maxillae united only at the tips; maxillipeds of the usual form, the terminal claw with two accessory spines on the inner margin.

Generic characters of male.—Head at right angles with the rest of the body, but so thoroughly fused as to show no trace of separation or segmentation; no dorsal carapace; body strongly inflated, the dorsal surface a semicircle, the ventral surface nearly straight, tapering posteriorly and terminating in two small anal laminae at right angles to the body axis.

First antennae three-jointed; second antennae biramose, the rami reduced to mere knobs; first maxillae tripartite; second maxillae and maxillipeds relatively very small, close together, and removed a little from the base of the mouth tube.

Type.—Parabrachiella rostrata (*Brachiella rostrata* Krøyer).

(*Parabrachiella, Παρα,* near and *Brachiella.*)

Remarks.—This genus includes at present only two species, *rostrata,* originally described by Krøyer in 1837 from halibut taken at Kattegat, and *insidiosa,* described by Heller in 1865 from a *Gadus* species in the Mediterranean. The former has been noted by numerous writers as found on the halibut along the coasts of Scandinavia, Scotland, and eastern North America. The latter has also been found in various portions of the Mediterranean and around the British Isles, chiefly upon hake, *Merluccius vulgaris.*

The female of the genus may be recognized by its large size, by the groove between the cephalothorax and trunk, by the absence of pits and grooves, and by the short posterior processes.

The male is distinguished by the angulation of the head, and by the fact that the body is neither segmented nor constricted.

TABLE OF SPECIES.

1. Only one pair of posterior processes...............*rostrata* (Krøyer), 1837, p. 714.
1. Two pairs of posterior processes..........................*insidiosa* (Heller), 1865.

PARABRACHIELLA ROSTRATA (Krøyer).

Plate 28, fig. O; plate 56, figs. 249 to 255.

Brachiella rostrata Krøyer, 1837, p. 207, pl. 2, fig. 1.—T. Scott, 1900, p. 174, pl. 8, figs. 38 and 39.

Host and record of specimens.—The United States National Museum collection includes two lots of this species; the first, three females, was taken from halibut near Shetland and was sent by Rev. A. M. Norman, of England, in 1884; they bear Cat. No. 8343, U.S.N.M. The second lot of four adult females with egg strings was obtained from halibut on the Georges Banks by a Gloucester fishing vessel in 1883, and bears Cat. No. 6212, U.S.N.M.

Specific characters of female.—Cephalothorax as long as the trunk, cylindrical, not flattened, and distinctly separated from the trunk by a groove behind the second maxillae; head not enlarged, but covered with a dorsal carapace which is squarely truncated anteriorly; neck about the same diameter throughout; trunk strongly flattened dorso-ventrally, four times the width but only twice the thickness of the neck; two minute conical posterior processes on the ventral surface close to the midline; egg strings one-half longer than the trunk and narrow; eggs in 10 longitudinal rows, about 40 in the longest rows.

First antennae indistinctly four-jointed, with an enlarged base; second antennae biramose and turned down squarely across the frontal margin, the endopod (dorsal ramus) one-jointed with a few minute spines, the exopod (ventral ramus) two-jointed and unarmed.

First maxillae bipartite with a small palp; second maxillae cylindrical, tapering toward the tips, where they are joined by a club-shaped bulla. Maxillipeds with a stout basal joint and a slender terminal claw; the latter is arched dorsally, straight ventrally, and is reinforced on the inner margin near the tip by two secondary spines.

Color (preserved material), a brownish-yellow.

Cephalothorax, 6 mm. long, 1.25 mm. in diameter. Trunk, 6.5 mm. long, 4 mm. wide, and 2.30 mm. thick. Egg strings, 8.50 mm. long, 1.25 mm. in diameter.

Specific characters of male.—Axis of head at right angles to that of the body, the two thoroughly fused, strongly inflated, and without any traces of separation or segmentation; trunk convex dorsally, flattened ventrally, and tapered posteriorly where it ends in two minute anal laminae, directed diagonally backward and ventrally.

First antennae slender and three-jointed; second antennae biramose, both rami reduced to mere knobs.

First maxillae tripartite, the palp minute and ending in a single spine; second maxillae slender but no longer than the maxillipeds; the latter a little stouter and with a stronger terminal claw.

Color like that of the female.

Total length, 2 mm. Greatest diameter, 1 mm.

(*rostrata*, furnished with a rostrum or beak.)

Remarks.—This species is apparently common upon the halibut of the northern Atlantic wherever they are captured. It is sufficiently distinguished by the characteristics given under the genus. Attention is particularly called to the strong contrast between the males of this genus and *Brachiella* in their general bodily appearance as well as in the details of the appendages.

EPIBRACHIELLA, new genus.

Generic characters of female.—Of medium size (10 mm. long); cephalothorax cylindrical and about the same length as the trunk, separated from the latter by a distinct groove; trunk strongly flattened dorso-ventrally and without pits or grooves; six short and pointed posterior processes, all about the same length; no genital process; egg strings much longer and stouter than the processes.

First antennae four-jointed, the basal joint much inflated; second antennae biramose and turned down across the frontal margin. First maxillae bipartite, the palp with two minute spines; second maxillae of varying length and branched at or near their center. Maxillipeds with a stout basal joint, armed on its inner margin with spines and setae, the terminal claw with an accessory spine and a row of saw teeth.

Generic characters of male.—Head and body in the same line and separated by a well-defined groove; no dorsal carapace; trunk a little wider than the cephalothorax and distinctly segmented, tapering posteriorly to two bluntly rounded anal laminae.

Second maxillae larger than the maxillipeds, the two attached to the center of the cephalothorax, close behind the other mouth parts; no data with reference to the antennae or maxillae.

Type.—*Epibrachiella impudica* (*Brachiella impudica* Nordmann.)

(*Epibrachiella*, ἐπί close to, and *Brachiella*.)

Remarks.—At present this genus includes but the single species *impudica*, which was well described and figured by Nordmann in 1832.

Since then it has been noticed by various other investigators up to 1899 when Bassett-Smith tried to change the species from the genus *Brachiella* to *Thysanote*. In this he was followed by T. and A. Scott (1900, 1902, 1904, and 1913). But if we compare the females we find in the present genus a total absence of the fimbriate processes, which are the chief characteristics of *Thysanote*, a very different cephalothorax, and numerous distinctions in the detail of the antennae and mouth parts. The males are even more unlike than the females in the separation of the cephalothorax and trunk and in the segmentation of the latter (see pl. 26, fig. F.).

PROBRACHIELLA, new genus.

Generic characters of female.—Cephalothorax nearly in line with the trunk and arched; head covered with a dorsal carapace; trunk subquadrilateral, a little narrowed anteriorly, separated from the cephalothorax by a well-defined groove; four pairs of posterior processes, one pair at the ventral, another at the dorsal, posterior corners, a third pair partly fused on the dorsal midline, and a fourth pair just outside the third and fused with them at their base; no abdomen, anal laminae, or genital process; egg strings short and spherical. First antennae indistinctly three-jointed; second antennae a flattened lamella, biramose at the tip but with the rami unsegmented and unarmed. First maxillae tripartite, without a palp; second maxillae very short and completely fused; maxillipeds with swollen basal joints and weak terminal claws.

Generic characters of male.—Cephalothorax at right angles to the trunk axis and separated from the trunk by a slight constriction; no dorsal carapace; trunk cone-shaped, somewhat flattened ventrally; no anal laminae. First antennae three-jointed; second antennae uniramose, indistinctly segmented, tipped with a claw and a corrugated knob. First maxillae like those of the female; second maxillae and maxillipeds about the same size and armed with powerful chelate claws (see pl. 28, fig. R.).

Type.—*Probrachiella anserina* (*Brachiella anserina* Wilson).

(*Probrachiella*, the prefix *Πρό* and *Brachiella*.)

Remarks.—The female is readily distinguished by the eight posterior processes and the spherical egg strings, neither character being found anywhere else in the entire family. In the male the turning of the cephalothorax at right angles to the trunk axis, and the general squat appearance of the body, the uniramose second antennae, and the chelate second maxillae and maxillipeds are the chief characteristics. This is an arctic species and may be far more common than the single lot of specimens would indicate. The fish around Bering Straits have hardly been examined at all for parasites; when they are, it is possible that this species will be found more abundantly.

When first described[1] this species was placed in the genus *Brachiella*, but when the characters of that genus were definitely established this species differed in so many particulars that it was necessary to establish a new genus for it. At present the generic and specific characters are the same.

EUBRACHIELLA, new genus.

Generic characters of female.—Cephalothorax about the same length as the trunk, inclined a little forward or nearly in the same line; no dorsal carapace; trunk stout and short and separated from the cephalothorax by a distinct groove; no abdomen, anal laminae, or posterior processes; genital process so rudimentary as to be scarcely visible; egg strings cylindrical and plump.

---

[1] Proc. U. S. Nat. Mus., vol. 35, p. 467.

First antennae three-jointed; second antennae biramose, both rami unsegmented, and unarmed. First maxillae tripartite, the palp with one spine; second maxillae short and stout, entirely separate and each maxilla attached separately to the host, or to a common bulla. Maxillipeds with a swollen basal joint, which is unarmed, and a slender terminal claw.

Generic characters of male.—Cephalothorax longer than the trunk and the two separated by a distinct constriction; head covered with a dorsal carapace; trunk bent in a half circle so that the posterior end points toward the head; no anal laminae or traces of segmentation. First antennae three-jointed; second antennae uniramose, tipped with a curved claw. First maxillae bipartite, without a palp; second maxillae a little larger than the maxillipeds, both tipped with stout claws. (See pl. 28, fig. P.)

Type.—*Eubrachiella antarctica* (*Brachiella antarctica* Quidor).

(*Eubrachiella*, *Eὖ* and *Brachiella.*)

Remarks.—This genus is distinguished by the fact that the female has no posterior processes, the rami of the second antennae are unsegmented, and the second maxillae are either entirely separate or are separately attached to a common bulla. The male differs even more, and shows a condition about half way between a typical *Brachiella* male and that found in the genus *Clavella* and its near relatives. The body has been folded upon itself until the posterior end of the trunk points as directly forward as in *Clavellodes*, but there has been no fusion, and the trunk is clearly differentiated from the cephalothorax; and according to Quidor the second antennae are uniramose and terminate in a prehensile claw. The genus includes two species, both obtained in the antarctic by the French expeditions under the command of Jean Charcot.

TABLE OF SPECIES.

1. Trunk quadrilateral, first maxillae tripartite.............*antarctica* (Quidor), 1906.
1. Trunk obcordate, first maxillae bipartite...................*gaini* (Quidor), 1912.

BIBLIOGRAPHY.

The following are referred to in the present paper:

1794. Abildgaard, P. C. Beskrivelse af en Gjelleorm paa Brasens Krop, Lernaea anomala. Skrivter af Naturh. Selsk., Kjöbenhavn, vol. 3, pp. 57, 58, unnumbered plate.

1909. Bainbridge, May E. (Hon. Mrs. Henn Collins). Notes on some Parasitic Copepoda; with a Description of a New Species of Chondracanthus. Trans. Linnean Soc., London, ser. 2, Zool., vol. 11, pt. 3, pp. 45 to 60, pls. 8–11.

1850. Baird, William. The Natural History of the British Entomostraca. The Ray Society, London, 1850.

1896. Bassett-Smith, P. W. Notes on the Parasitic Copepoda of Fish obtained at Plymouth, with Descriptions of New Species. Ann. Mag. Nat. Hist., ser. 6, vol. 18, pp. 1 to 16, pls. 3–6.

1898. ————. Further new Parasitic Copepods found on Fish in the Indotropical Region. Ann. Mag. Nat. Hist., ser. 7, vol. 2, pp. 77–98, pls. 3–6.

1870. Beneden, Édouard van. Recherches sur l'Embryogénie des Crustacés. IV. Développement des genres Anchorella, Lernaeopoda, Brachiella et Hessia. Bull. Acad. Royale Belgique, ser. 2, vol. 29, 1870, pp. 223–254, 1 plate.

1851. Beneden, P. J. van. Recherches sur quelques Crustacés inférieurs. Ann. des Sci. Natur., ser. 3, vol. 16, pp. 71–131, pls. 2–6.

1870. ————. Les Poissons des Côtes de Belgique, leurs Parasites, et leurs Commensaux. Mémoires Acad. Roy. Belgique, vol. 38, 90 pages, pls. 1–4.

1891. ————. Deux Lernéopodiens nouveaux recueillis, l'un aux Acores, l'autre sur les Côtes du Senegal. Bull. Acad. Roy. Belgique, ser. 3, vol. 22, pp. 23–35, pls. 1, 2.

1816. Blainville, Marie Henry Ducrotay de. Prodrome d'une nouvelle distribution systématique du règne animal. Bull. Sci. Soc. Phil. Paris, pp. 105–125.

1822. ————. Mémoire sur les Lernées. Journ. de Physique, vol. 95, pp. 372–380; 437–447, 1 plate.

1898. Brian, Alessandro. Catalogo di Copepodi Parassiti dei Pesci della Liguria. Atti Soc. Ligustica Sci. Nat. Geog., vol. 9, pp. 5–31, pls. 1–4.

1906. ————. Copepodi parassiti dei pesci d'Italia. Geneva, 189 pages, 21 plates (10 colored).

1908. ————. Note préliminaire sur les Copépodes parasites des Poissons provenant des Campagnes scientifiques de S. A. S. le Prince Albert I^er^ de Monaco ou déposés dans le Collections du Musée océanographique. Bull. Institut Océanographique, No. 110, 18 pages, 7 text figs.

1912. ————. Copépodes parasites des Poissons et des Echinides provenant des Campagnes scientifiques de S. A. S. le Prince Albert I^{er} de Monaco. Résultats des Campagnes scientifiques accomplis sur son Yacht par Albert I^{er} Prince Souverain de Monaco, fasc. 38, pp. 1–58, 12 plates.

1833. Burmeister, Hermann. Beschreibung einiger neuen oder wenig bekannten Schmarotzerkrebse. Acta Acad. Caes. Leop. Carol. Nat. Cur., vol. 17, pp. 271–336, pls. 23–25.

1862. Claus, Carl. Ueber den Bau und die Entwicklung von Achtheres percarum. Zeit. wiss. Zool., vol. 11, pp. 287–308, pls. 23, 24.

1895. ———— Ueber die Maxillarfüsse der Copepoden. Arb. Zool. Inst. Univ. Wien, vol. 11, pp. 49–63, pl. 8.

1872. Cope, Edward Drinker. On the Wyandotte Cave and its Fauna. Amer. Naturalist, vol. 6, pp. 406–422, text figures.

1852. Dana, James D. United States Exploring Expedition during the years 1838, 1839, 1840, 1841, 1842, under the command of Charles Wilkes, U. S. N., vol. 13, pt. 2, Poecilopoda, pp. 1309–1382, pls. 94–96.

1913a. Fasten, Nathan. The Brook Trout Disease in Wisconsin Waters. Report Wisconsin Commissioners of Fisheries, 1911–12, pp. 11–21, 4 unnumbered plates.

1913b. ———— The Behavior of a Parasitic Copepod, Lernaeopoda edwardsii Olsson. Journ. Animal Behavior, vol. 3, 1913, pp. 36–60, 5 text figures.

1914. ———— Fertilization in the Parasitic Copepod, Lernaeopoda edwardsii Olsson. Biol. Bull., vol. 27, pp. 115–121, pls. 1 to 3.

1901. Gadd, Pehr. Några förut obeskrifna, parasitiskt lefvande Copepoder. Meddel. Soc. Fauna et Flora Fennica, vol. 27, pp. 98–100.

1904. **Gadd, Pehr.** Parasit-Copepoder i Finland. Acta Soc. Fauna et Flora Fennica, vol. 26, No. 8, 60 pages, 2 plates.

1878. **Gerstaecker, A.** Gliederfüssler (Arthropoda). Bronn's Klassen und Ordungen des Thierreichs, vol. 5, pp. 590–806, pls. 7–15.

1893. **Giesbrecht, W.** Mitteilungen über Copepoden. VI. Zur Morphologie der Maxillipeden. Mitth. Zool. Stat. Neapel, vol. 11, pp. 83–102, pls. 5–7.

1827. **Grant, R. E.** On the Structure and Characters of the Lernaea elongata, Gr., a New Species from the Arctic Seas. Edinburgh Jour. Sci., vol. 7, pp. 147–154, pl. 2, fig. 5.

1893. **Hansen, H. J.** Zur Morphologie der Gliedmassen und Mundteile bei Crustaceen und Insekten. Zool. Anz., vol. 16, pp. 193–198, 201–212.

1865. **Heller, Camil.** Reise der Oesterreichischen Fregatte *Novara* um die Erde, vol. 2, pt. 3, Crustaceen. Wien, 1865, 280 pages, 25 plates.

1783. **Hermann, J. F.** Helmintologische Bemerkungen. Der Naturforscher, Halle, No. 19.

1863. **Hesse, Eugène.** Recherches sur quelques Crustacés rares ou nouveaux des Côtes de France. 3^{me} Mémoire, Naobranchia cygniformis. Ann. des. Sci. Nat., ser. 4, vol. 20, pp. 101–132, pl. 1.

1878. ———— Description des Crustacés rares ou nouveaux des Côtes de France. 3^{me} Art., Stylophorus hippocephalus. Ann. des Sci. Nat., ser. 6, vol. 8, 16 pages, pl. 28.

1892. **Kane, W. F. de Wismes.** On a new species of Lernaeopoda (bidiscalis) from the West Coast of Ireland and Polperro, Cornwall. Proc. Roy. Irish Acad. ser. 3, vol. 2, pp. 203–211, pls. 9, 10.

1880. **Kellicott, David S.** On Certain Crustacea parasitic on Fishes from the Great Lakes. Proc. Amer. Soc. Microscopists, vol. 1, pp. 53–57, 3 plates.

1868. **Kessler, K.** Materials toward a Knowledge of the Onega Sea and the District about it, particularly in its Zoological Aspects. Supplement to Work of the first Congress of Russian Naturalists in St. Petersburg, 143 pages, 8 plates, 1 map. In Russian.

1835. **Kollar, Vincenz.** Beiträge zur Kenntniss der Lernäenartigen Crustaceen. Annalen des Weiner-Museums, vol. 1, pp. 81–92, pls. 9, 10.

1837. **Krøyer, Henrik.** Om Snyltekrebsene, isaer med Hensyn til Danske Fauna. Naturhistorisk Tidskrift, vols. 1, 2, 1835–1838; vol. 1, pp. 172–208, 252–304, 476–505, 605–628, pls. 2, 3, 5, 6; vol. 2, pp. 7–52, 131–157, pls. 1, 3.

1863. ———— Bidrag til Kundskab om Snyltekrebsene. Idem, ser. 3, vol. 2, pp. 75–426, 18 plates.

1877. **Kurz, Wilhelm.** Studien uber die Familie der Lernaeopodiden. Zeit. wiss. Zool., vol. 29, pp. 380–428, pls. 25–27.

1818. **Lamarck, J. B. P.** Histoire Naturelle des Animaux sans vertèbres. Paris. 7 volumes. 8vo.

1735. **Linnaeus, Carolus.** Systema Naturae, edition 1, 1735; edition 10, 1757; edition 12, 1766; edition 13, 1788.

1746. ————. Fauna Suecica. Premiere edition, 1746; deuxieme edition, 1761, 1 volume. 8vo. Stockholm.

1860. **Malm, August Wilhelm.** Om flere for den skandinaviske Fauna nye Fiske, Krebsdyr og Bløddyr. Forhandl. ved de Skand. Naturf. Kjöbenhavn, pp. 616–623.

1824. **Mayor, M.** Notice sur une nouvelle espèce de Lernéopode. Bull. Sci. Soc. Phil. Paris, 1824, pp. 24, 25.

1904. **Miculicich, Miroslav.** Ein neuer Lernaeopodide. Zool. Anz., vol. 28, pp. 47–51, 3 text figures.

1877. **Miers, Edward J.** Report on the Crustacea collected by the Naturalists of the Arctic Expedition in 1875–6. Ann. Mag. Nat. Hist., ser. 4, vol. 20, pp. 52–66; 96–110, pls. 3, 4.

1840. Milne Edwards, Henri. Histoire Naturelle des Crustacés, Paris, 3 volumes. 8vo.

1776. Müller, Otho Frederic. Zoologiae Danicae Prodromus, Hafniae.

1909. Neresheimer, Eugen. Studien über süswasser Lernaeopodiden. Ber. bayr. Versuchsstät, München, vol. 2, 1909, pp. 1–9, 1 plate.

1832. Nordmann, Alex. v. Mikrographische Beiträge zur Naturgeschichte der wirbellosen Thiere. Zweites Heft, Berlin.

1815. Oken, W. Lehrbuch Naturgeschichte, 2 volumes. 8vo. Jena, 1815–16.

1869. Olsson, Petrus. Prodromus faunae Copepodorum parasitantium Scandinaviae. Lunds Universitets Års-skrift, År 1868 (pub. 1869), 49 pages, 2 plates.

1872. ———. Om en ny parasitisk Copepod. Oefv. Kongl. Vetensk. Akad. Förhandl., pp. 63–65, pl. 5.

1877. ———. Om Parasitiska Copepoder i Jemtland. Idem, 1877, pp. 75–88, pls. 4 to 6.

1874. Packard, A. S., Jr. Description of a Lernaean Crustacean (Achtheres carpenteri), obtained by Lieut. W. L. Carpenter in 1873 in Colorado. Ann Rep. U. S. Geol. Geog. Survey Territories (1873), p. 612, 1 text figure.

1906*a*. Quidor, Auguste. Sur les Copépodes recueillis par la mission Charcot et communiqués par M. E. L. Bouvier. Compt. Rend., vol. 142, pp. 54 to 56.

1906*b*. ———. Sur les Copépodes recueillis par la mission Charcot dans les mers Antarctiques. Bull. Mus. Nat. Hist., Paris, vol. 12, pp. 27–33, 3 plates.

1912. ———. Deuxième Expédition Antarctique Française (1908–1910), Sciences Naturelles, pp. 197–214, pls. 1–4.

1829. Retzius, Anders. Beskrifning öfver en ny Skandinavisk Lernaea från Nordsjön, kallad Lernaea dalmanni. Kongl. svenska vetensk. Akad. Handl., pp. 109–119, pl. 6.

1880. Richiardi, S. Catalogo sistematico dei Crostacei che vivono sul corpo degli animali acquatici. Espositione internazionale di Pesca in Berlino, 1880, pp. 147–152.

1832. Rudolphi, Charles Asmund. Ueber Dirhynchus fistula, luciopercae und malleus. Manuscript notices handed to Nordmann and published by him, p. 50.

1786. Schrank, Francois-de-Paule. Voyage en Bohême. Nuremberg.

1900. Scott, Thomas. Notes on Some Crustacean Parasites of Fishes. 18th Ann. Report Fishery Board, Scotland, pp. 144–187, pls. 5–8.

1901. ———. Notes on Some Parasites of Fishes. 19th Ann. Report Fishery Board, Scotland, pp. 120–153, pls. 7, 8.

1913. Scott, T. and A. The British Parasitic Copepods. London. Printed for the Ray Society, 1913–14. 2 volumes. 8vo.

1874. Smith, Sidney I. The Crustacean Parasites of the Fresh-water Fishes of the U. S. Report U. S. Com. Fish and Fisheries for 1872–3 (pub. 1874), pp. 661–665, pl. 3.

1861. Steenstrup, J. Japetus, and Lütken, Chr. Fred. Bidrag til Kundskab om det aabne Havs Snyltekrebs og Lernaeer. Kong. Dan. Vidensk. Selsk. Skrifter, ser. 5, vol. 5, pp. 343–432, pls. 1–5.

1899. Thomson, George M. Parasitic Copepoda of New Zealand with Descriptions of New Species. Trans. New Zealand Institute, vol. 22, pp. 353–375, pls. 25–29.

1862. Turner, William, and Wilson, H. S. On the Structure of Lernaeopoda dalmanni with Observations on its Larval Form. Trans. Roy. Soc. Edinburgh, vol. 23, pp. 77–87, pl. 4.

1880. Valle, Antonio. Crostacei parassiti dei Pesci del Mare Adriatico. Boll. Soc. Adr. Sci. Nat., Trieste, vol. 6, pp. 55–90.

1877. Vogt, Carl. Recherches Côtières. De la Famille des Lernaeopodides. Mém. Inst. nat. génevois, vol. 13, pp. 45–73, pls. 3, 4.

1908. Wilson, Charles B. North American Parasitic Copepods: List of those found upon the Fishes of the Pacific Coast with descriptions of new Genera and Species. Proc. U. S. Nat. Mus., vol. 35, pp. 431–481, pls. 66–83.

1910. ————. The Development of Achtheres ambloplitis Kellicott. Proc. U. S. Nat. Mus., vol. 39, pp. 189–226, pls. 29–36.

1911. ————. North American Parasitic Copepods belonging to the Family Ergasilidae. Proc. U. S. Nat. Mus., vol. 39, pp. 263–400, pls. 41–60.

1882. Wright, R. Ramsay. Notes on American Parasitic Copepods. Proc. Canadian Institute, n. s., vol. 1, pp. 243–254, pls. 1, 2.

EXPLANATION OF PLATES.

Plate 25.

Male genus types.

Fig. A. *Achtheres ambloplitis*. Fig. B. *Lernaeopoda bidiscalis* (after Kane). Fig. C. *Brachiella thynni*. Fig. D. *Lernaeopodina relata*.

Plate 26.

Male genus types.

Fig. E. *Clavellisa cordata*. Fig. F. *Epibrachiella impudica* (after Nordmann). Fig. G. *Thysanote longimana*. Fig. H. *Thysanotella multifimbriata* (after Bassett-Smith). Fig. I. *Charopinus dentatus*.

Plate 27.

Male genus types.

Fig. J. *Naobranchia lizae*. Fig. K. *Clavellopsis laciniata*. Fig. L. *Clavellodes rugosa* Fig. M. *Clavella uncinata*.

Plate 28.

Male genus types.

Fig. N. *Vanbenedenia krøyeri* (after Olsson). Fig. O. *Parabrachiella rostrata*. Fig. P. *Eubrachiella antarctica* (after Quidor). Fig. R. *Probrachiella anserina*.

Plate 29.

Females of *Salmincola californiensis* and *S. salmonea*.

Fig. 16, dorsal view, *S. californiensis* (after Dana). Fig. 17, side view. Fig. 18, side view, *S. salmonea*. Fig. 19, dorsal view of head. Fig. 20, side view, showing first (a^1) and second (a^2) antennae, and first maxilla (mx^1). Fig. 21, maxilliped. Fig. 22, genital process enlarged, showing spermatophores (s) in position. Fig. 22*a*, first antenna. Fig. 22*b*, second antenna. Fig. 22*c*, mandible. Fig. 22*d*, first maxilla.

Plate 30.

Females of *Salmincola siscowet* and *S. edwardsii*.

Fig. 23, side view, *S. siscowet*. Fig. 24, dorsal view of head. Fig. 25, second antenna. Fig. 26, mandible. Fig. 27, first maxilla. Fig. 28, maxilliped. Fig. 29, papilla of maxilliped enlarged. Fig. 30, side view, *S. edwardsii*. Fig. 31, dorsal view of head. Fig. 32, second antenna. Fig. 33, mandible. Fig. 34, first maxilla. Fig. 35, maxilliped.

PLATE 31.

Females of *Salmincola oquassa*, *S. bicauliculata* and *S. falculata*.

Fig. 36, side view, *S. oquassa*. Fig. 37, dorsal view of head. Fig. 38, second antenna. Fig. 39, first maxilla. Fig. 40, maxilliped. Fig. 41, side view, *S. bicauliculata*. Fig. 42, dorsal view of head. Fig. 43, side view, *S. falculata*. Fig. 44, dorsal view of head (inverted).

PLATE 32.

Females of *Salmincola thymalli*, *S. inermis*, and *S. beani*.

Fig. 45, side view, *S. thymalli*. Fig. 46, dorsal view of head. Fig. 47, side view, *S. inermis*. Fig. 48, dorsal view of head. Fig. 49, first antenna. Fig. 50, second antenna. Fig. 51, first maxilla. Fig. 52, side view, *S. beani*. Fig. 53, dorsal view of head.

PLATE 33.

Females of *Salmincola carpenteri* and *S. gibber*.

Fig. 54, side view, *S. carpenteri*. Fig. 55, dorsal view of head. Fig. 56, second antenna. Fig. 57, mandible. Fig. 58, first maxilla. Fig. 59, maxilliped. Fig. 60, side view, young female, showing genital process. Fig. 61, side view, *S. gibber*. Fig. 62, dorsal view of head.

PLATE 34.

Females of *Achtheres corpulentus* and *A. micropteri*.

Fig. 63, dorsal view, *A. corpulentus* (after Kellicott). Fig. 64, dorsal view, *A. micropteri*. Fig. 65, ventral view of antennae and mouth parts; *a^1* and *a^2*, first and second antennae; *mx*, first maxilla; *mxp*, maxilliped. Fig. 66, first antenna, enlarged. Fig. 67, mandible.

PLATE 35.

Females of *Achtheres micropteri* and *A. lacae*.

Fig. 68, side view, *A. micropteri*. Fig. 69, dorsal view of head. Fig. 70, side view, *A. lacae*. Fig. 71, dorsal view of head. Fig. 72, mouth tube, first and second antennae and first maxilla. Fig. 73, second antenna, side view. Fig. 74, maxilliped.

PLATE 36.

Female of *Achtheres coregoni* and male of *A. ambloplitis*.

Fig. 75, side view, *A. coregoni*. Fig. 76, dorsal view of head. Fig. 77, side view of antennae and mouth parts, enlarged. Fig. 78, second antenna. Fig. 79, maxilliped. Fig. 80, ventral view of posterior trunk, showing small abdomen. Fig. 81, side view, *A. ambloplitis*. Fig. 82, first and second antennae and mouth tube. Fig. 83, second antennae from inner side. Fig. 84, first maxilla. Fig. 85, maxillipeds.

PLATE 37.

Female of *Achtheres ambloplitis*.

Fig. 86, dorsal view. Fig. 87, side view. Fig. 88, dorsal view of head. Fig. 89, ventral view of antennae and mouth parts. Fig. 90, mandible. Fig. 91, bulla.

PLATE 38.

Female of *Achtheres pimelodi*.

Fig. 92, dorsal view. Fig. 93, side view. Fig. 94, dorsal view of head. Fig. 95, antennae and mouth parts, lettering as in fig. 65.

PLATE 39.

Female of *Achtheres percarum* and males of *Lernaeopoda elongata* and *Lernaeopodina relata.*

Fig. 96, side view, *A. percarum.* Fig. 97, dorsal view of head. Fig. 98, side view, young male, *L. elongata.* Fig. 99, side view, *L. relata.* Fig. 100, second maxilla. Fig. 101, maxilliped.

PLATE 40.

Male and female of *Lernaeopodina relata* and female of *Tracheliastes grandis.*

Fig. 102, side view of mouth parts and antennae, *L. relata,* male. Fig. 103, side view of female. Fig. 104, ventral view of antennae and mouth parts. Fig. 105, maxilliped. Fig. 106, ventral view, *T. grandis.* Fig. 107, side view of antennae and mouth tube. Fig. 108, maxilliped

PLATE 41.

Females of *Brianella corniger,* and *Charopinus bicaudatus.*

Fig. 109, side view, *B. corniger.* Fig. 110, front view of head; an^1 and an^2 first and second antennae. Fig. 111, side view of same, flattened under pressure. Fig. 112, side view, natural condition; *lb,* labium. Fig. 113, maxillipeds. Fig. 114, dorsal view of head of *C. bicaudatus.* Fig. 115, first antennae. Fig. 116, mandible. Fig. 117, first maxilla. Fig. 118, maxilliped.

PLATE 42.

Females of *Charopinus bicaudatus* and *Naobranchia lisae.*

Fig. 119, side view, *C. bicaudatus.* Fig. 120, ventral view of antennae and mouthparts; an^1 and an^2, first and second antennae; mx^1, first maxilla. Fig. 121, median section of *N. lizae; a,* anus; *i,* intestine; mx^2, second maxillae; *n,* thickened cartilage around the muscle strands; *oe,* esophagus; *s,* stomach *sr,* semen receptacle; *x, y,* and *z,* points at which the enlarged figures 123, 126, and 133 were taken; *, point corresponding to the one in the shoulders where the maxillary glands are situated. Fig. 122, median section of head, enlarged; *fg,* frontal gland; *ig,* and *sg,* infra and supra-esophageal ganglia; *m,* mouth; *oe,* esophagus; *p,* posterior nerve; *s,* stomach. Fig. 123, section *x* of fig. 121, enlarged; *gc,* gland cells of stomach; *s,* skin; *sct,* subcutaneous tissue. Fig. 124, section of second maxillae; *m,* muscle bands; *o,* open spaces connecting the muscle bands; *s,* skin.

PLATE 43.

Female of *Naobranchia lizae.*

Fig. 125, maxillary gland. Fig. 126, section *z* of fig. 121, enlarged. Fig. 127, side view of adult. Fig. 128, side view of young, showing maxillae freed at their tips. Fig. 129, side view of head, showing the peculiar lateral appendages. Fig. 130, second antennae. Fig. 131, ventral view of fused trunk and abdomen. Fig. 132, dorsal view.

PLATE 44.

Female and male of *Naobranchia occidentalis.*

Fig. 133, section *y* of fig. 121, enlarged. Fig. 134, section of egg, showing blastoderm disk and large central vacuoles. Fig. 135, ventral view of antennae and mouth parts of *N. lizae.* Fig. 136, dorsal view, *N. occidentalis.* Fig. 137, ventral view of antennae and mouth parts. Fig. 138, ventral view of head, showing peculiar lateral appendages. Fig. 139, side view of male.

PLATE 45.

Female and male of *Clavella perfida*, and female of *C. tumida*.

Fig. 140, side view, *C. perfida*, female. Fig. 141, ventral view, showing genital process and maxillary glands. Fig. 142, ventral view of antennae and mouth parts. Fig. 143, side view of male. Fig. 144, side view, *C. tumida*. Fig. 145, ventral view of antennae and mouth parts. Fig. 146, first maxilla. Fig. 147, maxilliped of male.

PLATE 46.

Male of *Clavella tumida*, female and male of *C. canaliculata*, and female of *C. insolita*.

Fig. 148, side view, male *C. tumida*. Fig. 149, side view, female *C. canaliculata*. Fig. 150, ventral view of antennae and mouth parts. Fig. 151, side view of male. Fig. 152, ventral view of *C. insolita*. Fig. 153, antennae and mouth parts, *an'* and *an²*, first and second antennae; *mx'*, first maxilla; *mxp*, maxilliped.

PLATE 47.

Female of *Clavella levis*, and female and male of *Clavella pinguis*.

Fig. 154, side view, *C. levis*. Fig. 155, antennae and mouth parts. Fig. 156, side view of adult female of *C. pinguis*. Fig. 157, side view of young female. Fig. 158, antennae and mouth parts. Fig. 159, second maxillae showing line of separation. Fig. 160, side view of male. Fig. 161, antennae and first maxilla, enlarged.

PLATE 48.

Female of *Clavella squamigera*, and female and male of *Clavella uncinata*.

Fig. 162, side view, *C. squamigera*. Fig. 163, ventral view, showing scales around second maxillae. Fig. 164, antennae and mouth parts. Fig. 165, second antennae. Fig. 166, maxilliped. Fig. 167, first antenna and first maxilla of female *C. uncinata*. Fig. 168, maxilliped. Fig. 169, section through the center of the bulla. Fig. 170, side view of male. Fig. 171, first and second antennae of male. Fig. 172, first maxilla. Fig. 173, maxilliped.

PLATE 49.

Female of *Clavella uncinata*, female and male of *C. irina*, and female of *Clavellopsis robusta*.

Fig. 174, antennae and mouth parts of *C. uncinata*. Fig. 175, mandible. Fig. 176, claw of maxilliped (last two figures by R. Rathbun). Fig. 177, side view of female of *C. irina*. Fig. 178, antennae and mouth parts. Fig. 179, ventral view of posterior trunk, showing genital process and peculiar fleur-de-lis. Fig. 180, side view of male. Fig. 181, second antenna. Fig. 182, dorsal view of *C. robusta*, showing short posterior processes.

PLATE 50.

Females of *Clavella recta* and *Clavellopsis producta*, and female and male of *Clavellisa spinosa*.

Fig. 183, side view, *C. recta*. Fig. 184, antennae and mouth parts. Fig. 185, side view, *C. producta*. Fig. 186, antennae and mouth parts. Fig. 187, cell filament and egg of *Clavellisa cordata*. Fig. 188, antennae and mouth parts of *C. spinosa*. Fig. 189, side view of male.

PLATE 51.

Female and male of *Clavellodes rugosa*.

Fig. 190, ventral view of cephalothorax and dorsal view of trunk. Fig. 191, dorsal view of head. Fig. 192, ventral view. Fig. 193, first antenna. Fig. 194, second antenna. Fig. 195, same, different view. Fig. 196, first maxilla. Fig. 197, maxilliped. Fig. 198, longitudinal section of male; *e*, blind end of intestine; *fg*, frontal gland; *ig* and *sg*, infra- and supra- esophageal ganglia; *gc*, gland cells; *mp*, maxillipedal gland; *oe*, esophagus; *s*, stomach; *sp*, spermatozoa; *sph*, spermatophore; *stc*, spermatocyte; *stg*, spermatogonia; *t*, testis. Fig. 199, first and second antennae of male.

PLATE 52.

Female of *Clavellisa spinosa*, and female and male of *Clavellisa cordata*.

Fig. 200, ventral view of cephalothorax and dorsal view of trunk of *C. spinosa*. Fig. 201, ventral view of female of *C. cordata*. Fig. 202, side view. Fig. 203, antennae and mouth parts. Fig. 204, first antenna. Fig. 205, second antenna. Fig. 206, mandible. Fig. 207, maxilliped. Fig. 208, side view of male.

PLATE 53.

Female and male of *Brachiella thynni* and of *B. gulosa*.

Fig. 209, side view, *B. thynni*. Fig. 210, dorsal view of trunk. Fig. 211, second antennae and first maxillae. Fig. 212, second antenna, enlarged. Fig. 213, maxilliped. Fig. 214, side view of male. Fig. 215, antennae and first maxillae. Fig. 216, posterior trunk of *B. gulosa*, showing genital process. Fig. 217, first maxilla. Fig. 218, maxilliped. Fig. 219, side view of male. Fig. 220, first and second antennae, after sketch by M. T. Thompson.

PLATE 54.

Females of *Brachiella gulosa* and *B. mitrata*, and female and male of *B. elegans*.

Fig. 221, side view, *B. gulosa*. Fig. 222, antennae and mouth parts. Fig. 223, second antenna, enlarged (from M. T. Thompson). Fig. 224, mandible. Fig. 225, antennae and mouth parts of *B. mitrata*. Fig. 226, first antenna of *B. elegans*, female. Fig. 227, second antenna, both antennae by M. T. Thompson. Fig. 228, first maxilla. Fig. 229, maxilliped. Fig. 230, side view of male of *B. elegans*. Fig. 231, first and second antennae by M. T. Thompson. Fig. 232, first maxilla. Fig. 233, claw of second maxilla.

PLATE 55.

Females of *Brachiella elegans* and *B. mitrata*, and female and male of *B. pinguis*.

Fig. 234, side view, *B. elegans*. Fig. 235, side view, *B. mitrata*. Fig. 236, first antenna. Fig. 237, first maxilla. Fig. 238, maxilliped. Fig. 239, first antenna and first maxilla of *B. pinguis*. Fig. 240, second antenna. Fig. 241, maxilliped. Fig. 242, side view of male *B. pinguis*. Fig. 243, first antenna. Fig. 244, second antenna.

PLATE 56.

Females of *Brachiella pinguis*, *B. nitida*, and *Parabrachiella rostrata*.

Fig. 245, side view, *B. pinguis*. Fig. 246, side view, *B. nitida*. Fig. 247, antennae and mouth parts. Fig. 248, maxilliped. Fig. 249, side view, *P. rostrata*. Fig. 250, antennae and mouth parts, drawn by R. Rathbun. Fig. 251, second antenna. Fig. 252, mandible. Fig. 253, first maxilla. Fig. 254, second maxilla of male. Fig. 255, maxilliped of male.

INDEX.

Page.

- Achtheres, genus, 617
- Achtheres amblopitis, 626
  - carpenteri, 618
  - coregoni, 623
  - corpulentus, 619
  - lacae, 622
  - micropteri, 620
  - percarum, 629
  - pimelodi, 628
  - sandrae, 619
  - selachiorum, 618
- Anchorella, genus, 667
- Anchorella adunca, 667
  - agilis, 668
  - angulata, 668
  - anomala, 668
  - appendiculata, 668
  - appendiculosa, 668
  - canthari, 669
  - carusi, 668
  - centrodonti, 669
  - characis, 668
  - clava, 668
  - crassa, 668
  - denticis, 668
  - dilatata, 669
  - elongata, 668
  - emarginata, 669
  - fallax, 669
  - hostilis, 669
  - intermedia, 669
  - laciniata, 669
  - lagenula, 669
  - lichiae, 668
  - lizae, 669
  - microcephala, 669
  - ovalis, 670
  - pagelli, 668
  - paradoxa, 670
  - quadrata, 670
  - rugosa, 670
  - sargi, 670
  - sciaenophila, 670
  - scombri, 670
  - simplex, 668
  - stellata, 670
  - subtilis, 668
  - tenuis, 668
  - triglae, 670
  - urolophi, 670

Page.

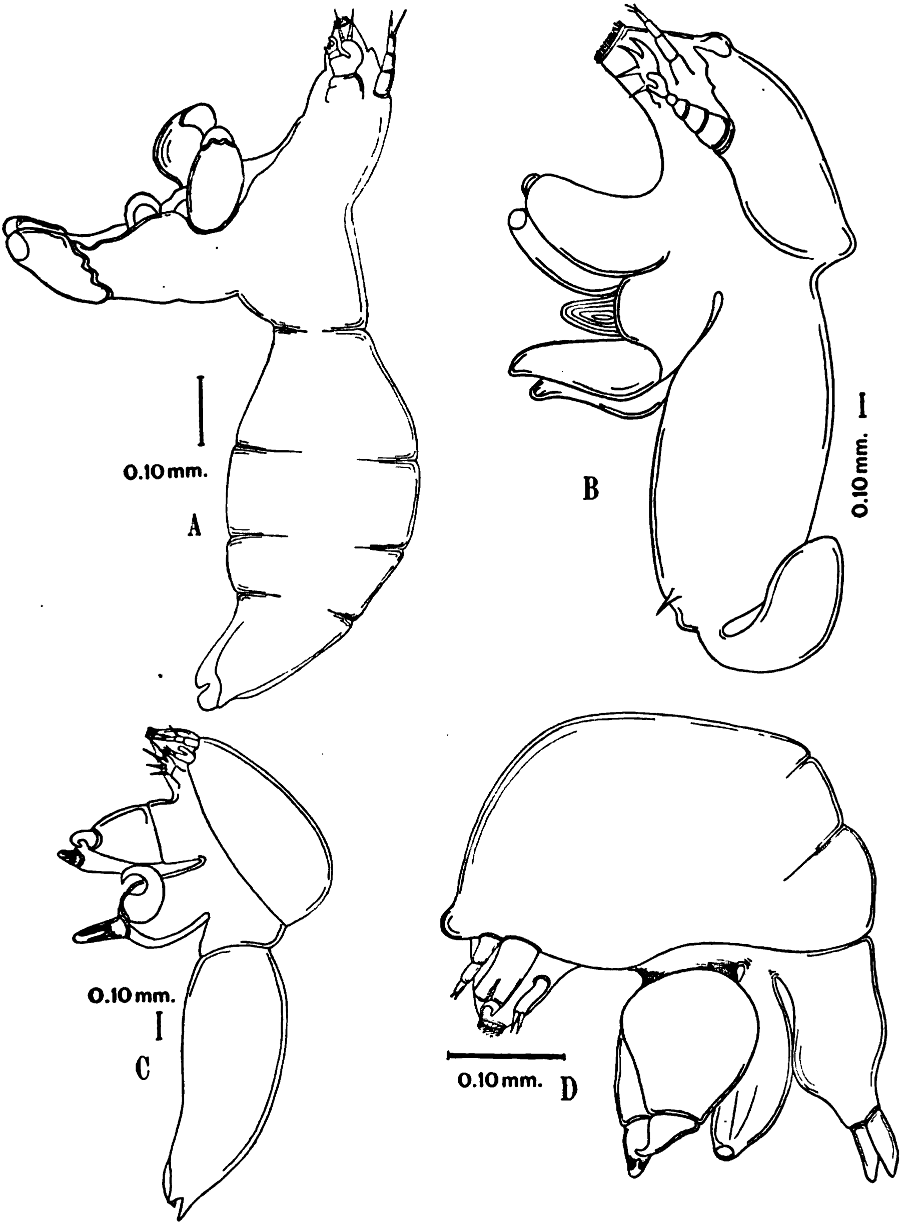
- Antennae, 577
- Antennules, 577
- Appendages, 578
- Basanistes, genus, 643
- Basanistes coregoni, 643
  - huchonis, 643
  - nordmanni, 643
- Bibliography, 717
- Body form, female, 571
- Body form, male, 574
- Brachiella, genus, 698
- Brachiella anserina, 699
  - antarctica, 699
  - appendiculata (Krøyer), 702
  - appendiculata (Steenstrup and Lütken), 700
  - appendiculosa (Krøyer), 712
  - appendiculosa (B. Smith), 700
  - bispinosa, 702
  - chavesii, 703
  - chevreuxii, 702
  - concava, 703
  - dentata, 700
  - elegans, 707
  - exigua, 702
  - fimbriata, 700
  - gaini, 700
  - gracilis, 712
  - gulosa, 705
  - hostilis, 702
  - impudica, 700
  - inconcinna, 700
  - insidiosa, 700
  - lobiventris, 700
  - lophii, 700
  - malleus, 700
  - merluccii, 703
  - minuta, 700
  - mitrata, 709
  - multifimbriata, 700
  - neglecta, 700
  - nitida, 711
  - obesa, 701
  - oblonga, 701
  - ovalis, 701
  - parkeri, 701
  - pastinacae, 701
  - pernettiana, 701
  - pinguis, 710

Page.
Brachiella ramosa 700
rostrata 702
sciaenophila 703
thynni 703
triglae 702
Brianella, genus 647
Brianella corniger 647
Brianellinae, subfamily 646
Bulla 581
Cauloxenus, genus 665
Cauloxenus stygius 665
Cement glands 590
Cestopoda, genus 602
Charopinus, genus 652
Charopinus bicaudatus 656
cluthae 654
dalmanni 655
dentatus 654
dubius 654
hippocephalus 654
malleus 654
ramosus 654
Circulation 586
Clavella, genus 666
Clavella agilis 668
alata 672
angulata 668
bergyltae 671
brevicollis 672
canaliculata 675
canthari 669
characis 668
denticis 672
dubia 672
insolita 676
inversa 673
irina 685
levis 677
macrotrachelus 669
obesa 670
pagelli 672
pagri 671
parva 676
perfida 672
pinguis 678
quadrata 672
recta 684
robusta 670
sciaenae 670
squamigera 679
stellata 670
stichaei 671
strumosa 670
tumida 674
uncinata 680
Clavellinae, subfamily 649
Clavellisa, genus 693

Page.
Clavellisa cordata 697
emarginata 694
ovalis 696
scombri 694
spinosa 694
Clavellodes, genus 689
Clavellodes intermedia 690
macrotrachelus 690
rugosa 690
Clavellopsis, genus 686
Clavellopsis fallax 687
laciniata 687
paradoxa 687
producta 688
robusta 688
sargi 687
strumosa 687
Copepodid stages 593
Digestive system 587
Ecology 566
Epibrachiella, genus 715
Epibrachiella impudica 715
Esophagus 587
Eubrachiella, genus 716
Eubrachiella antarctica 717
gaini 717
Excretory system 588
Explanation of plates 721
Eye 576
Food 570
Hosts 569
Intestine 587
Introduction 565
Lernaeomyzon, genus 602
Lernaeopoda, genus 631
Lernaeopoda alpina 632
arcturi 632
beani 632
bicaudata 632
bicauliculata 632
bidiscalis 635
brongniartii 634
californiensis 605
carpionis 606
clavigera 632
cluthae 639
coregoni 632
coregonorum 632
cyprinacea 633
dalmanni 633
edwardsii 609
elongata 637
extensa 632
extumescens 632
falculata 632
fontinalis 633
galei 635

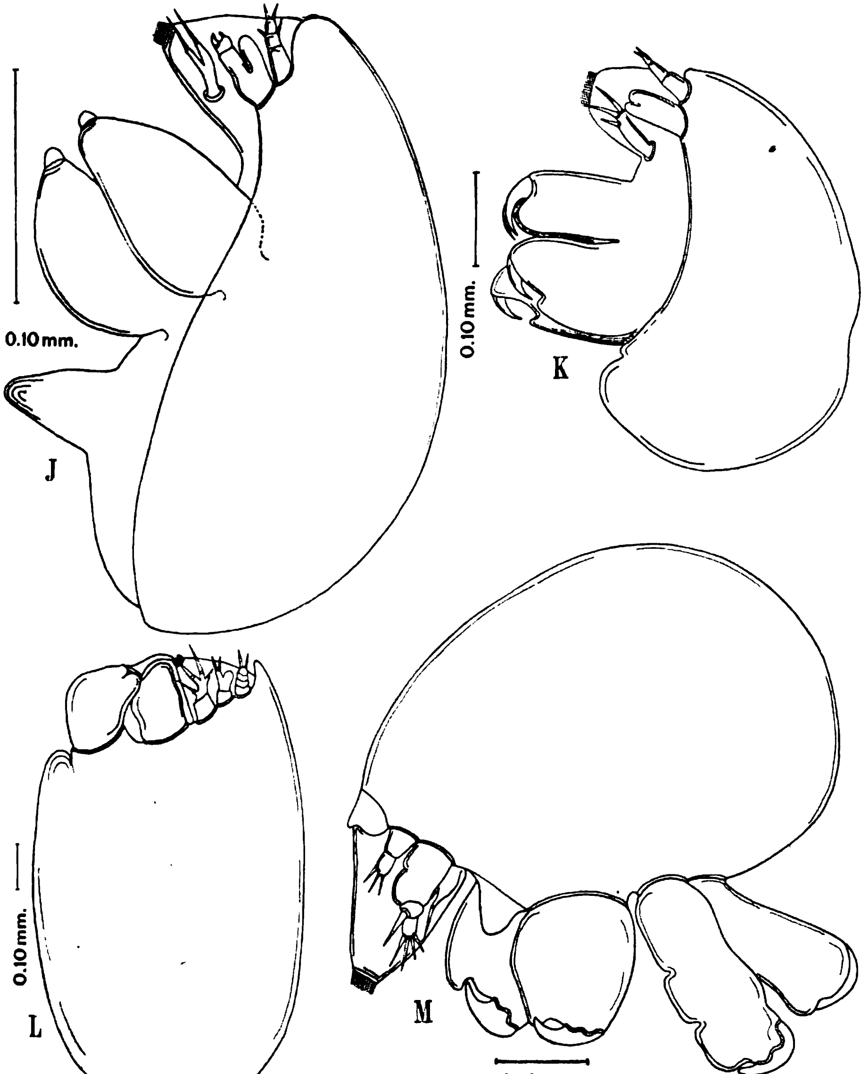
	Page.
Lernaeopoda gibber	632
inermis	632
lampri	633
longibrachia	633
longimana	633
lotae	632
maraenae	632
musteli	633
obesa	633
salmonea	632
scyllii	633
sebastis	633
similis	640
siscowet	608
spinacis	640
stellata	634
thymalli	632
Lernaeopodidae, family	598
Lernaeopodina, genus	639
Lernaeopodina cluthae	640
longibrachia	641
longimana	640
relata	641
similis	640
spinacis	640
Lernaeopodinae, subfamily	603
Locomotion	567
Mandibles	578
Maxillae	580
Maxillipeds	581
Metanauplius	592
Morphology	571
Mouth tube	577
Muscles, dorsal	582
ventral	583
of second maxillae	583
of appendages	584
special	584
of male	585
Muscular system	582
Naobranchia, genus	657
Naobranchia amplectens	660
cygniformis	659
lizae	660
occidentalis	663
Nauplius	592
Nervous system	588
Ontogeny	591
Parabrachiella, genus	713
Parabrachiella insidiosa	713
rostrata	714
Pediculus, genus	601
Prehension	568
Proboscis	577

	Page.
Probrachiella, genus	716
Probrachiella anserina	716
Reproductive system	589
Respiration	586
Salmincola, genus	603
Salmincola alpina	604
arcturi	605
beani	615
bicauliculata	612
californiensis	605
carpenteri	616
carpionis	606
coregonorum	604
edwardsii	609
extensa	605
extumescens	605
falculata	613
gibber	615
inermis	614
lotae	604
maraenae	605
oquassa	611
salmonea	607
siscowet	608
thymalli	613
Schisturus, genus	602
Sexual dimorphism	566
Spermatophores	589
Sperm receptacles	589
Stomach	587
Stylophorus, genus	602
Swimming legs	576
Systematic	596
Thomsonella, genus	649
Thomsonella parkeri	649
Thynnicola, genus	602
Thysanote, genus	650
Thysanote appendiculata	651
fimbriata	651
lobiventris	651
longimana	651
pomacanthi	651
Thysanotella, genus	651
Thysanotella multifimbriata	652
Tracheliastes, genus	644
Tracheliastes gigas	645
grandis	645
maculatus	645
polycolpus	645
stellifer	645
Tracheliastinae, subfamily	644
Vanbenedenia, genus	644
Vanbenedenia krøyeri	644



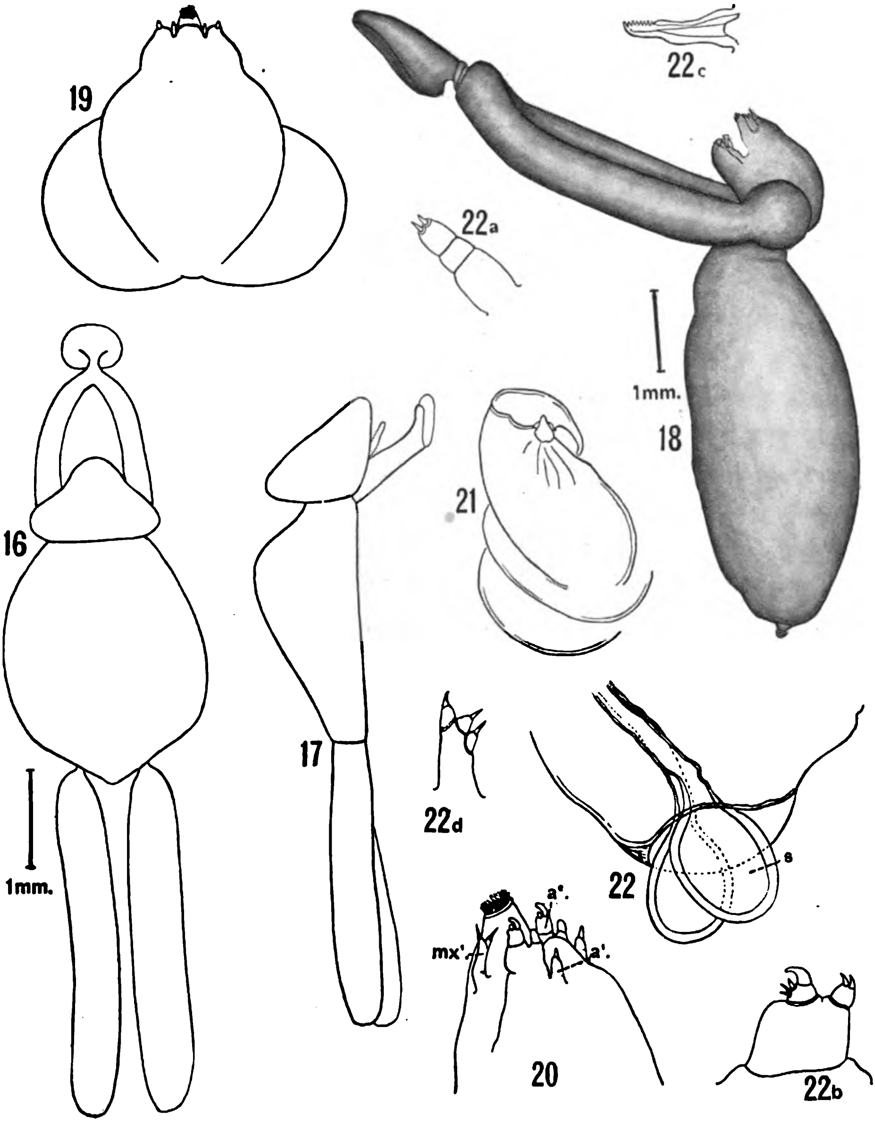
MALE GENUS TYPES.

FOR EXPLANATION OF PLATE SEE PAGE 721.



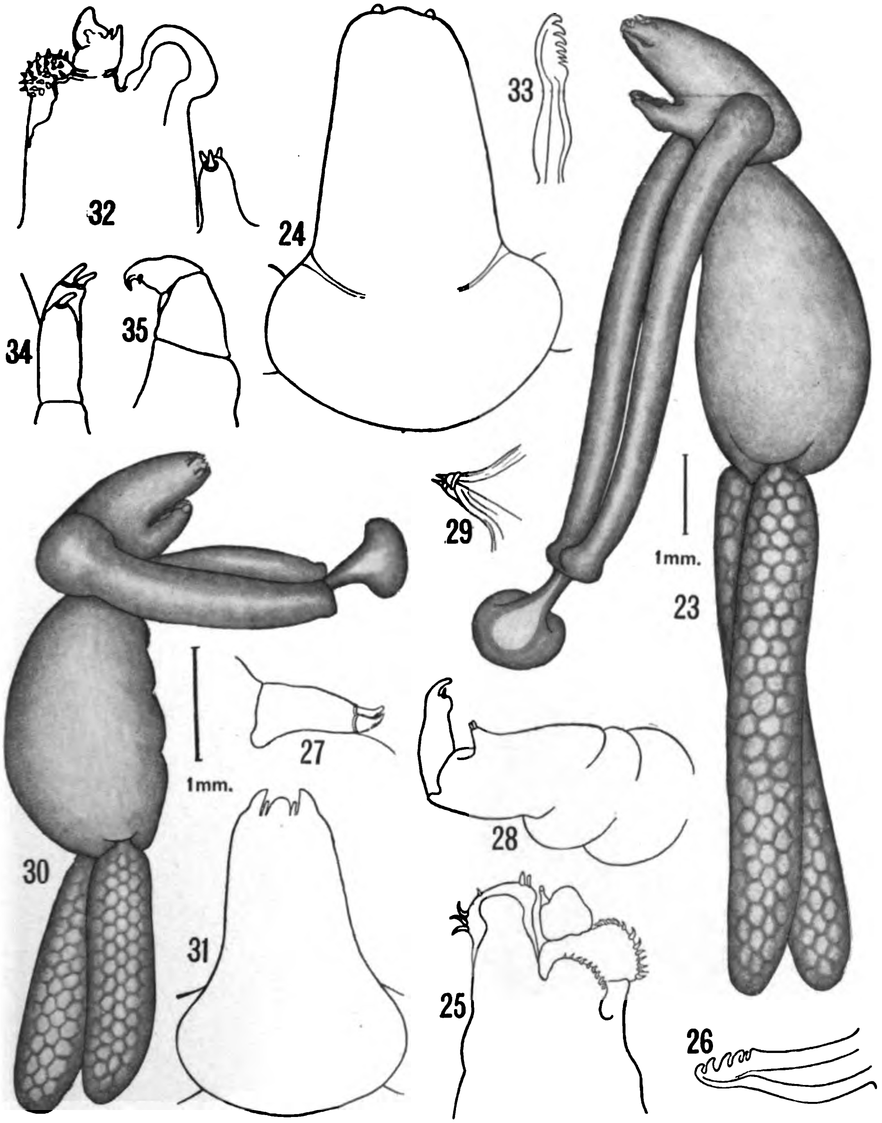
MALE GENUS TYPES.

FOR EXPLANATION OF PLATE SEE PAGE 721.



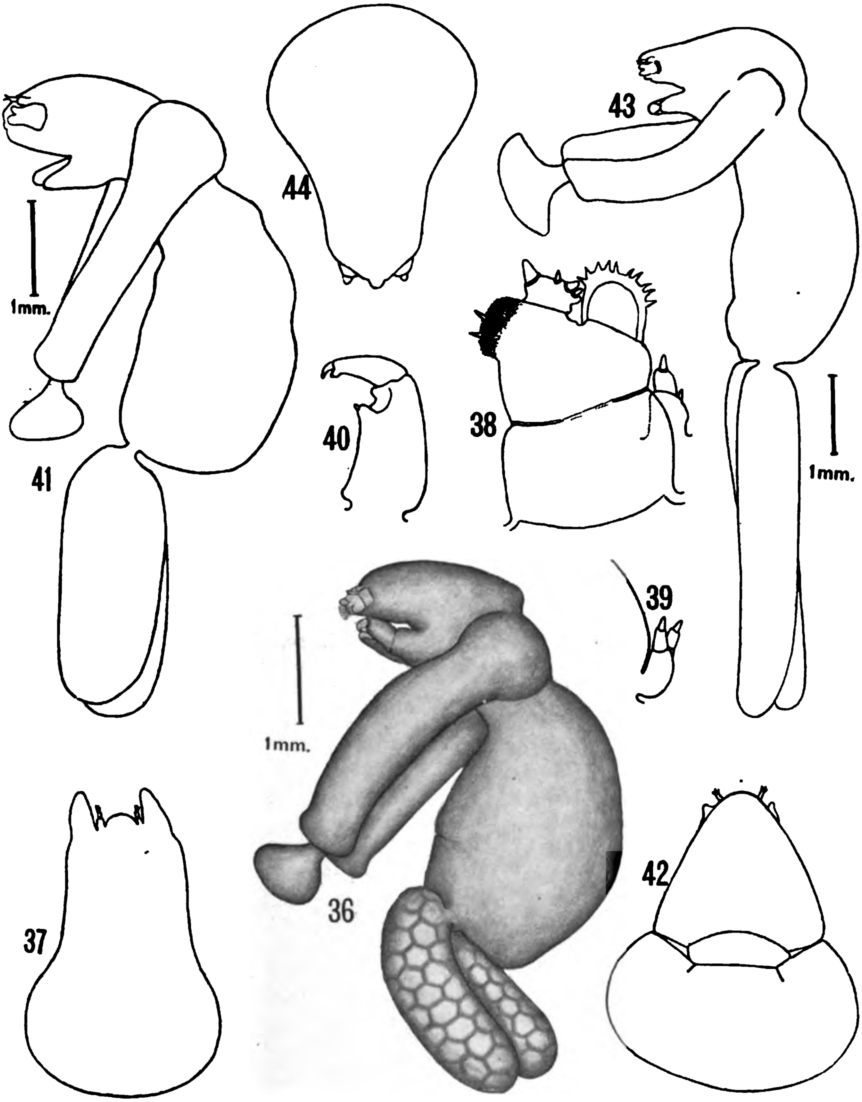
FEMALES OF SALMINCOLA CALIFORNIENSIS AND S. SALMONEA.

FOR EXPLANATION OF PLATE SEE PAGE 721.



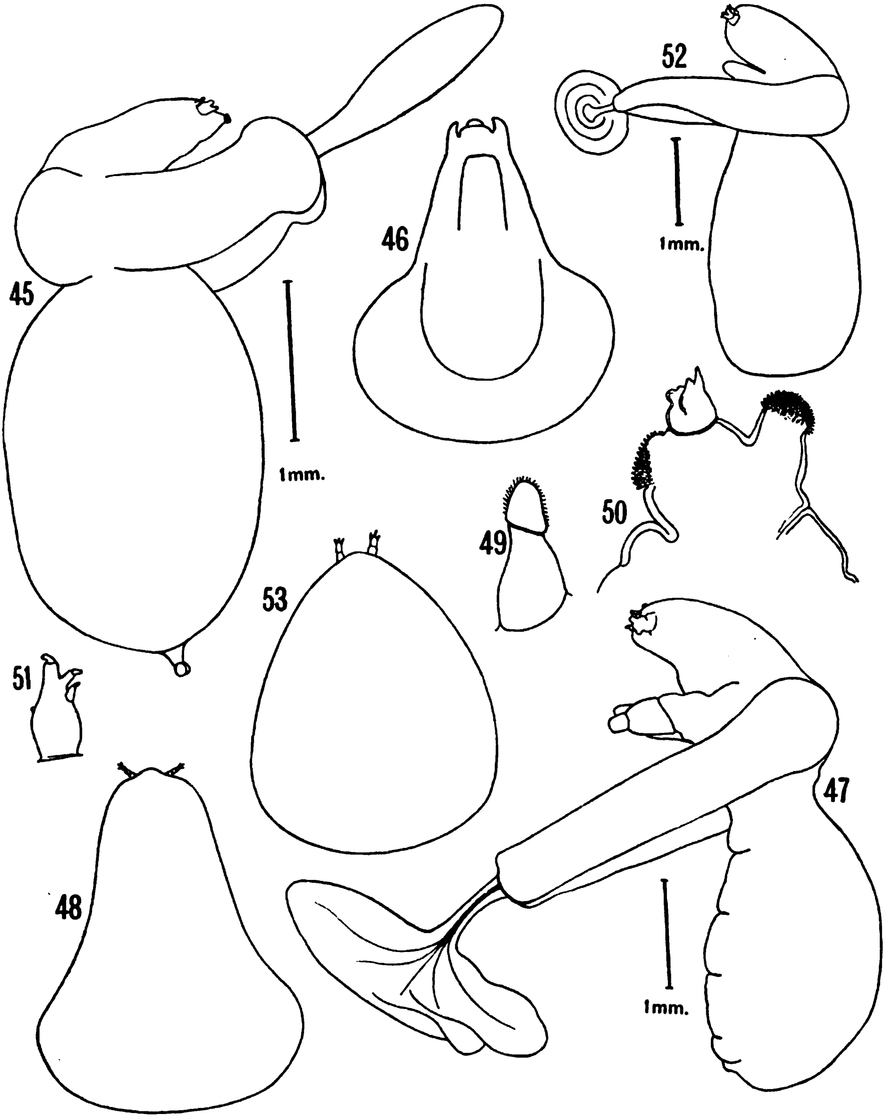
FEMALES OF SALMINCOLA SISCOWET AND S. EDWARDSII.

FOR EXPLANATION OF PLATE SEE PAGE 721.



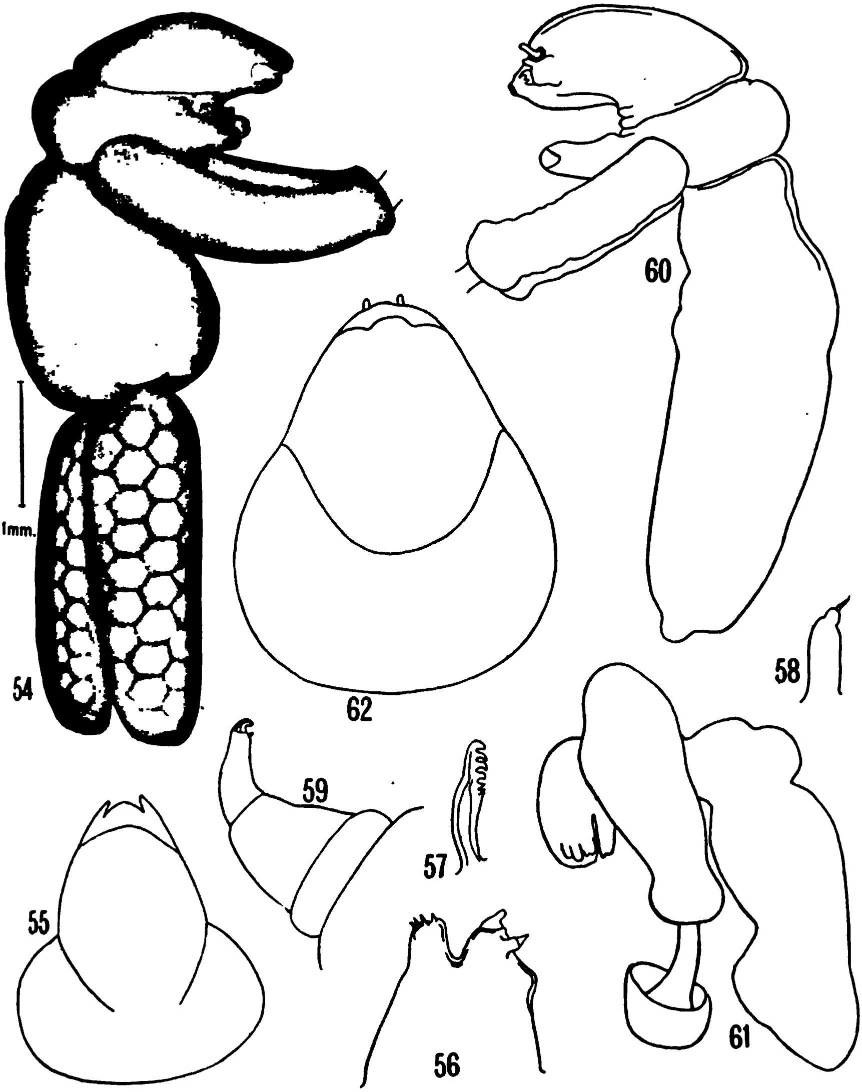
FEMALES OF SALMINCOLA OQUASSA, S. BICAULICULATA, AND S. FAUCULATA.

FOR EXPLANATION OF PLATE SEE PAGE 722.



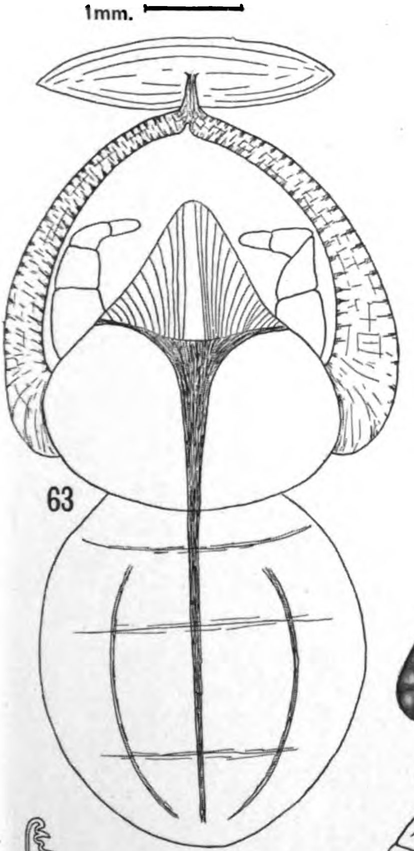
FEMALES OF SALMINCOLA THYMALLI, S. INERMIS, AND S. BEANI.

FOR EXPLANATION OF PLATE SEE PAGE 722.

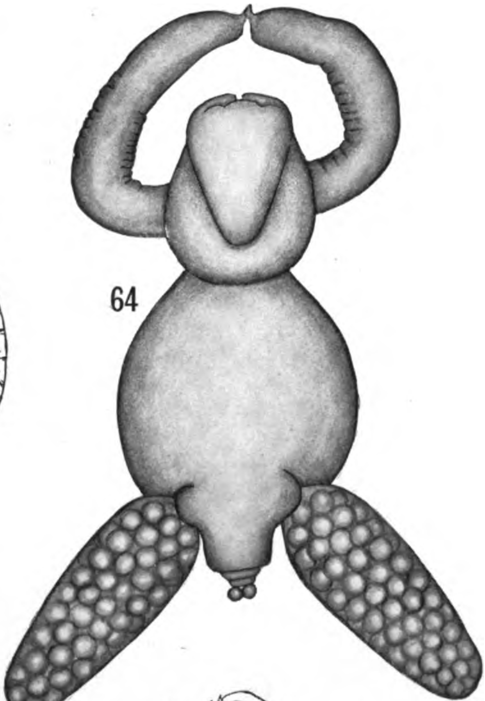


Females of Salmincola carpenteri and S. gibber.

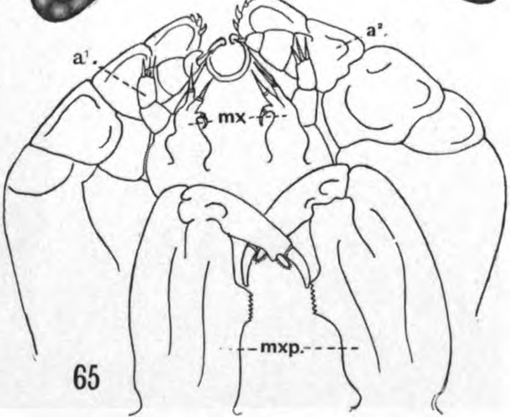
For explanation of plate see page 722.



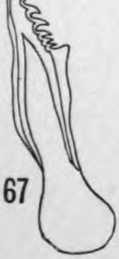
63



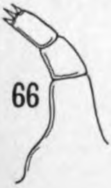
64



65



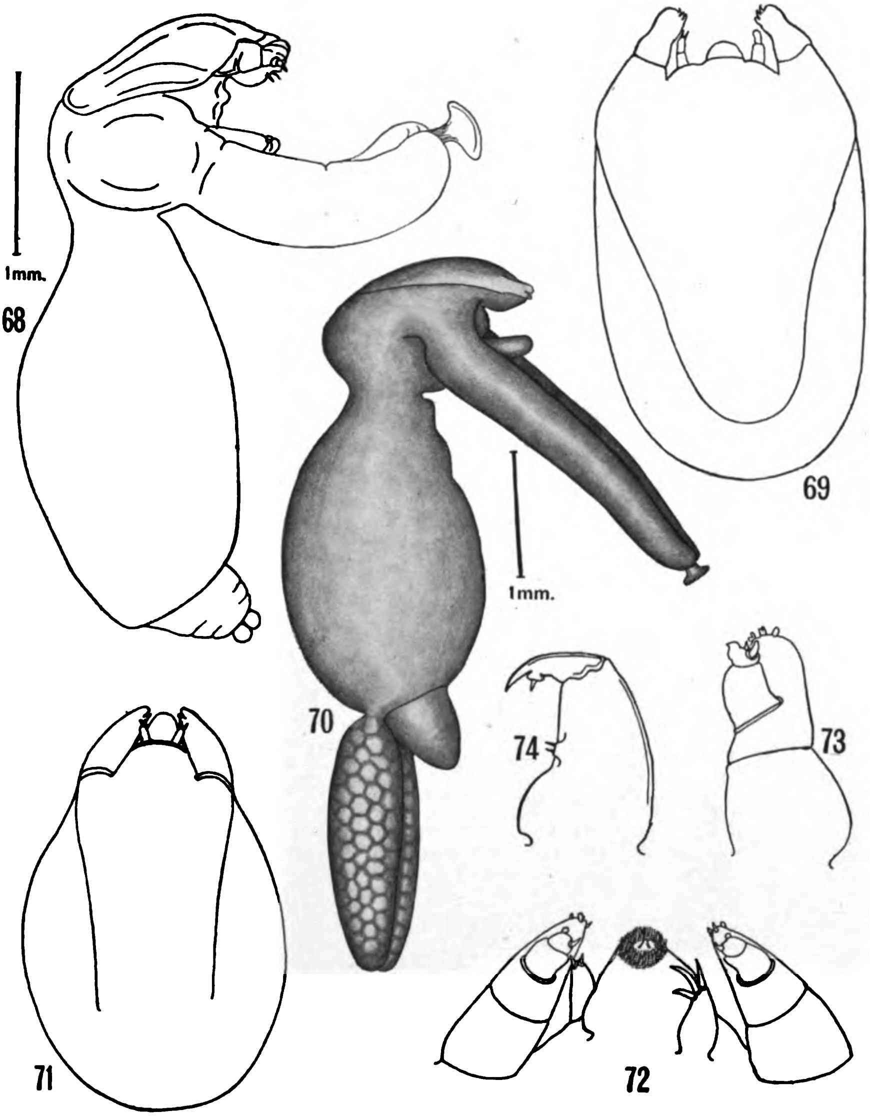
67



66

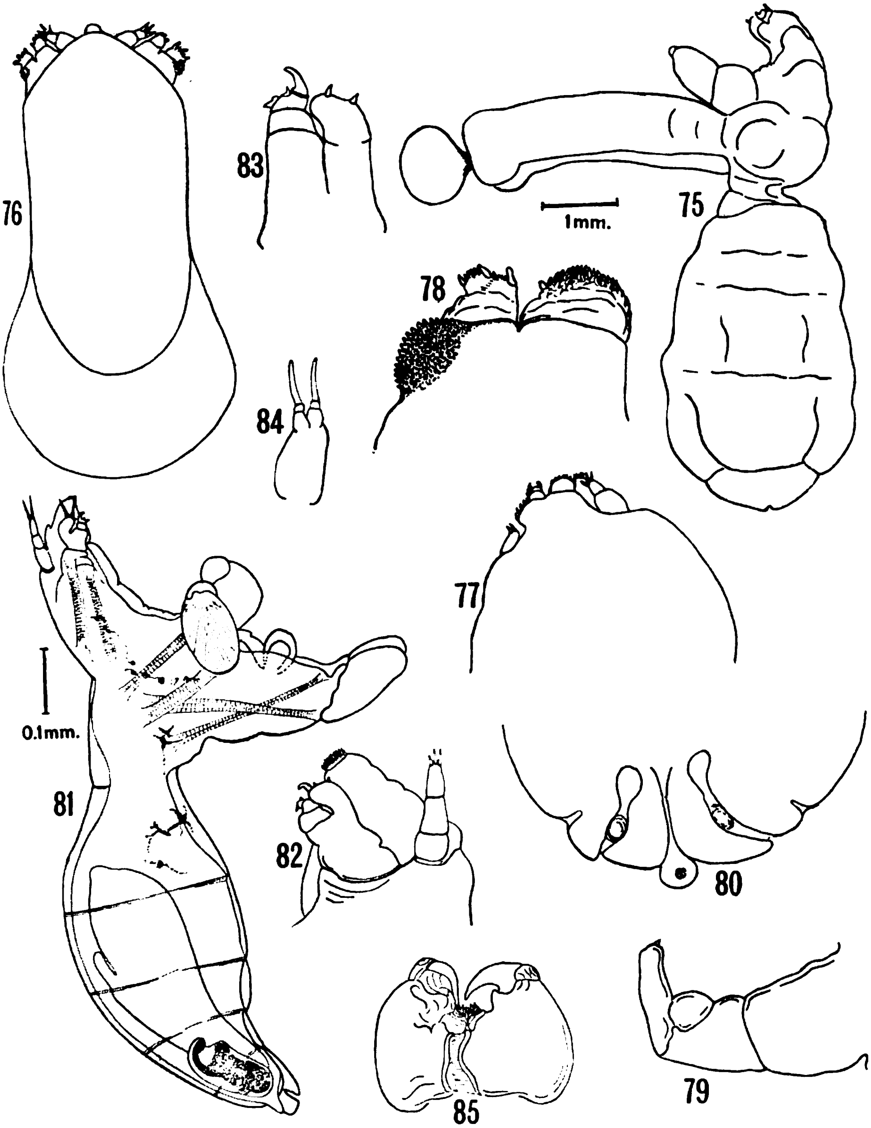
FEMALES OF ACHTHERES CORPULENTUS AND A. MICROPTERI.

FOR EXPLANATION OF PLATE SEE PAGE 722.



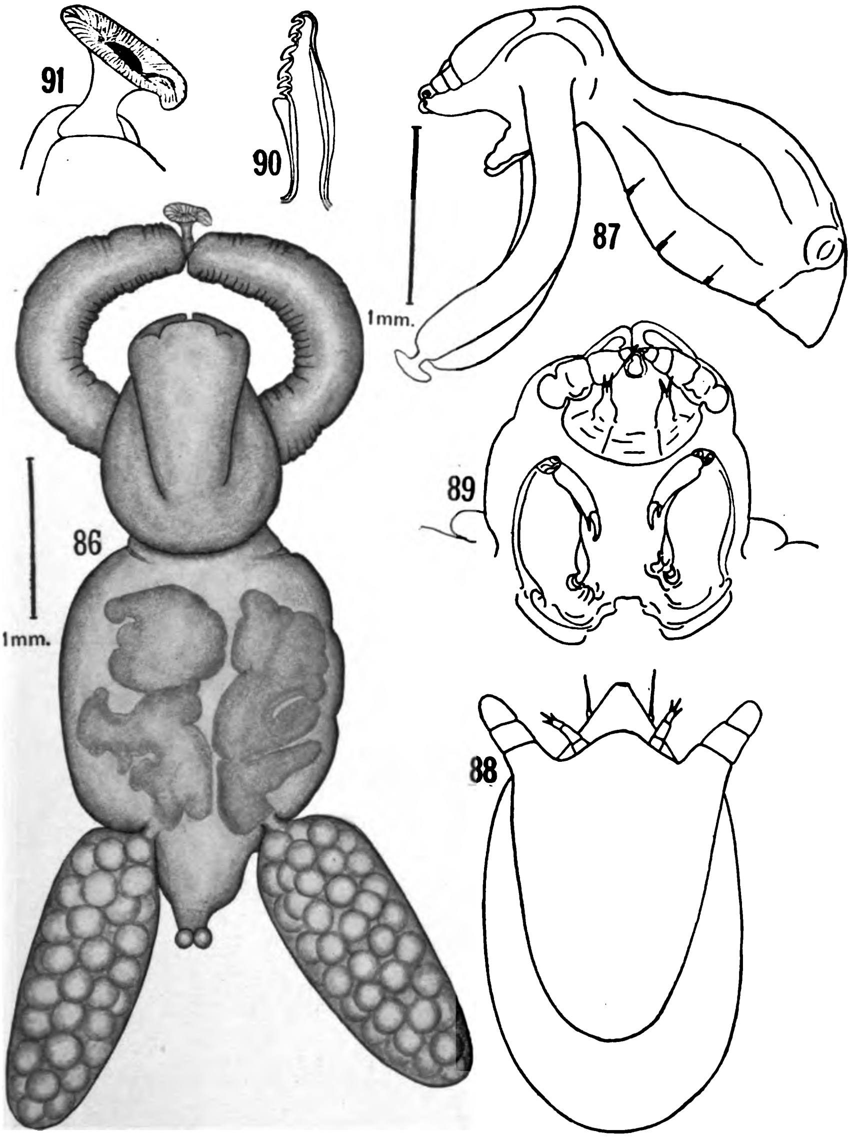
FEMALES OF ACHTHERES MICROPTERI AND A. LACAE.

FOR EXPLANATION OF PLATE SEE PAGE 722.



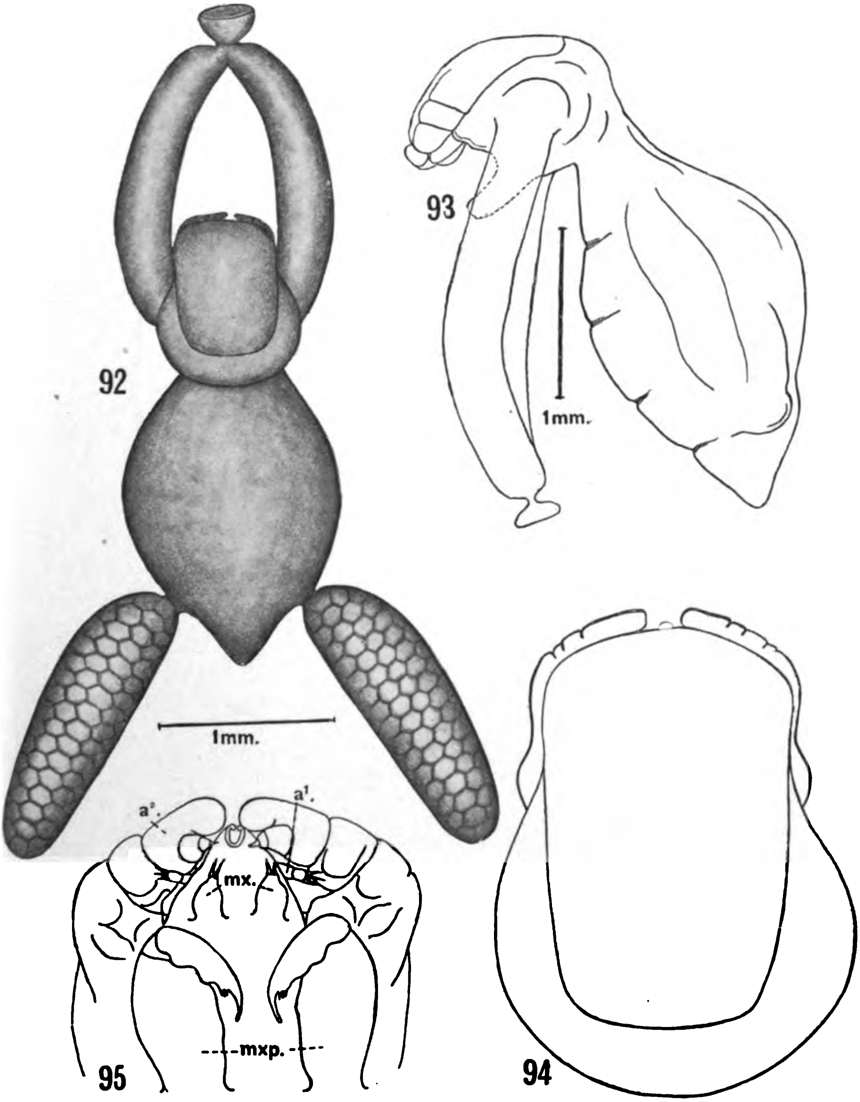
FEMALE OF ACHTHERES COREGONI AND MALE OF A. AMBLOPLITIS

FOR EXPLANATION OF PLATE SEE PAGE 722.



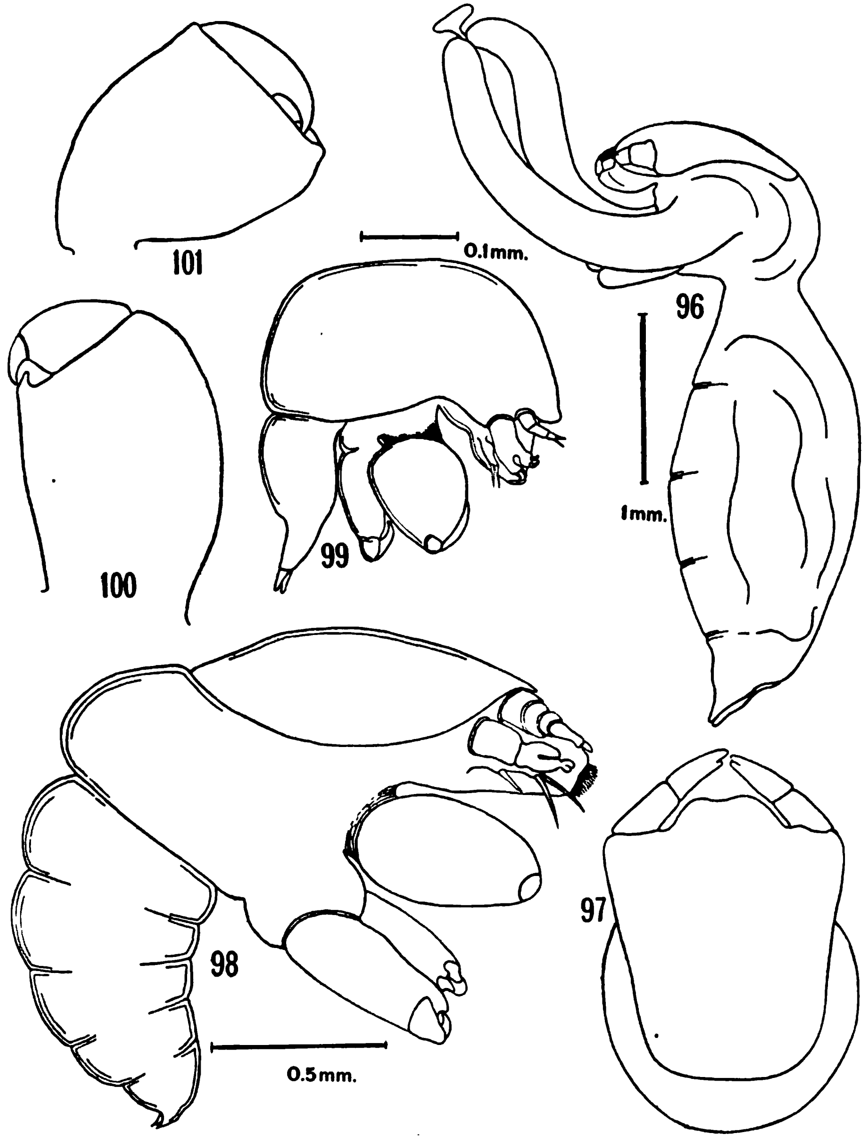
Female of Achtheres ambloplitis.

For explanation of plate see page 722.



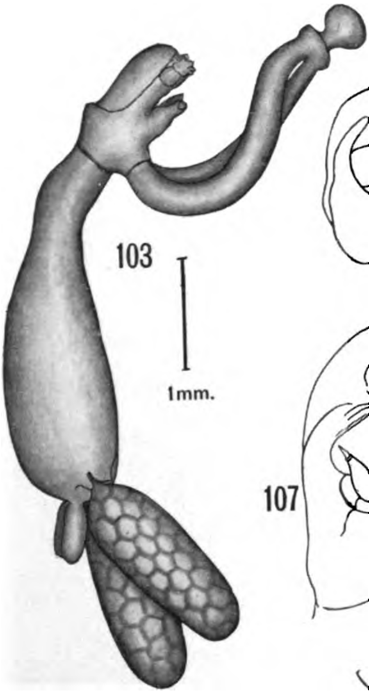
FEMALE OF ACHTHERES PIMELODI

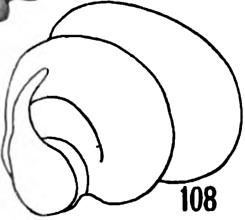
FOR EXPLANATION OF PLATE SEE PAGE 722.

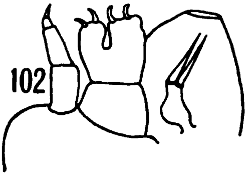


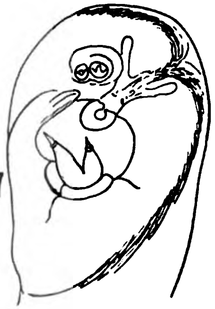
FEMALES OF ACHTHERES PERCARUM AND MALES OF LERNAEOPODA ELONGATA AND LERNAEOPODINA RELATA.

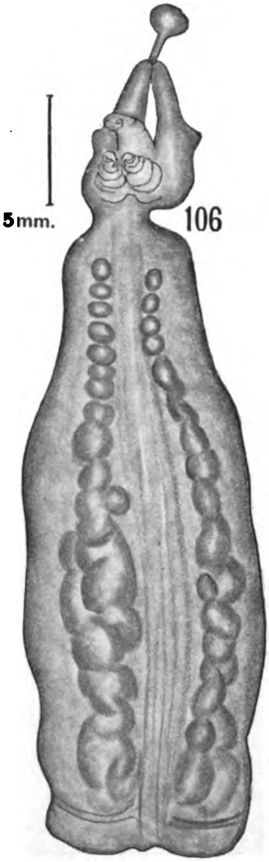
FOR EXPLANATION OF PLATE SEE PAGE 723.


103

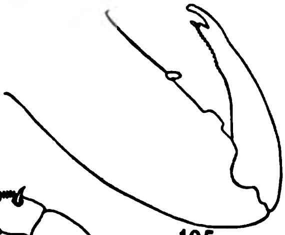

108

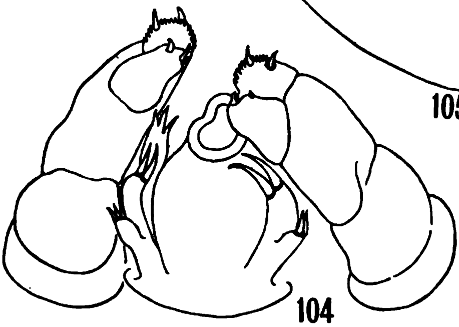

102


107



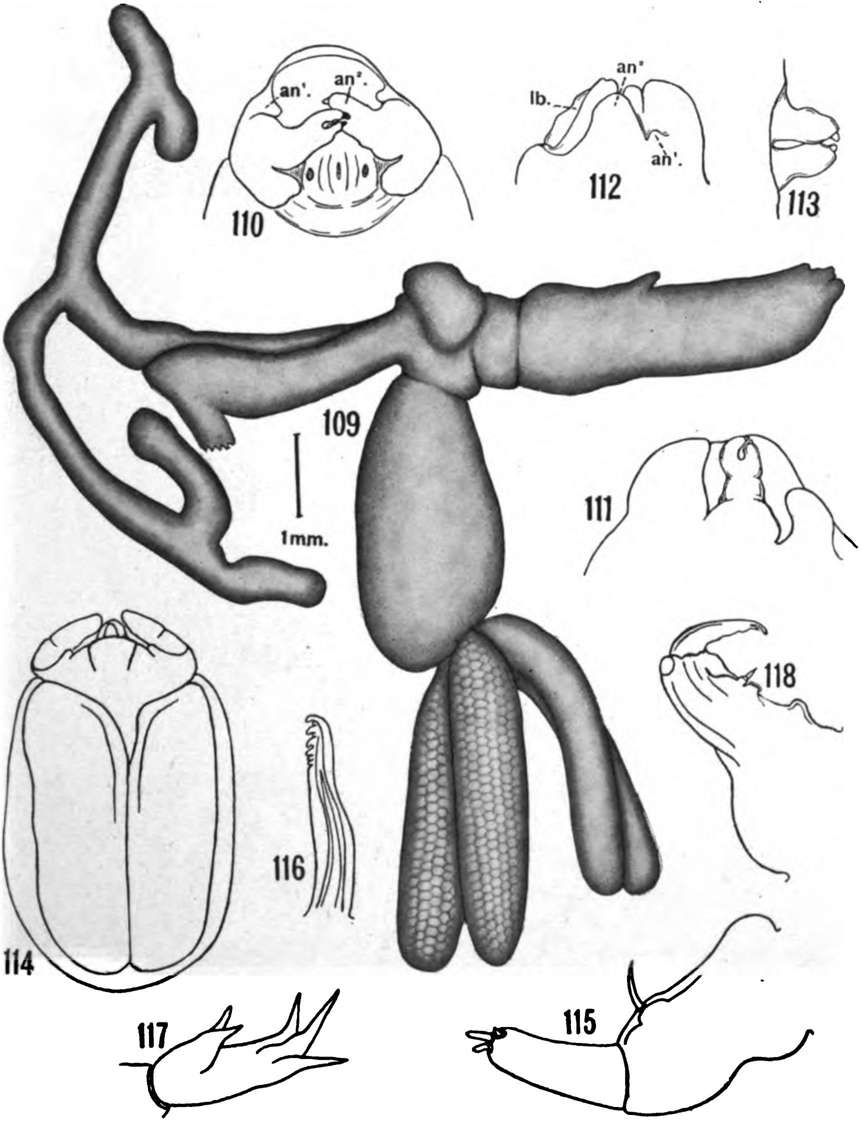
106


105


104

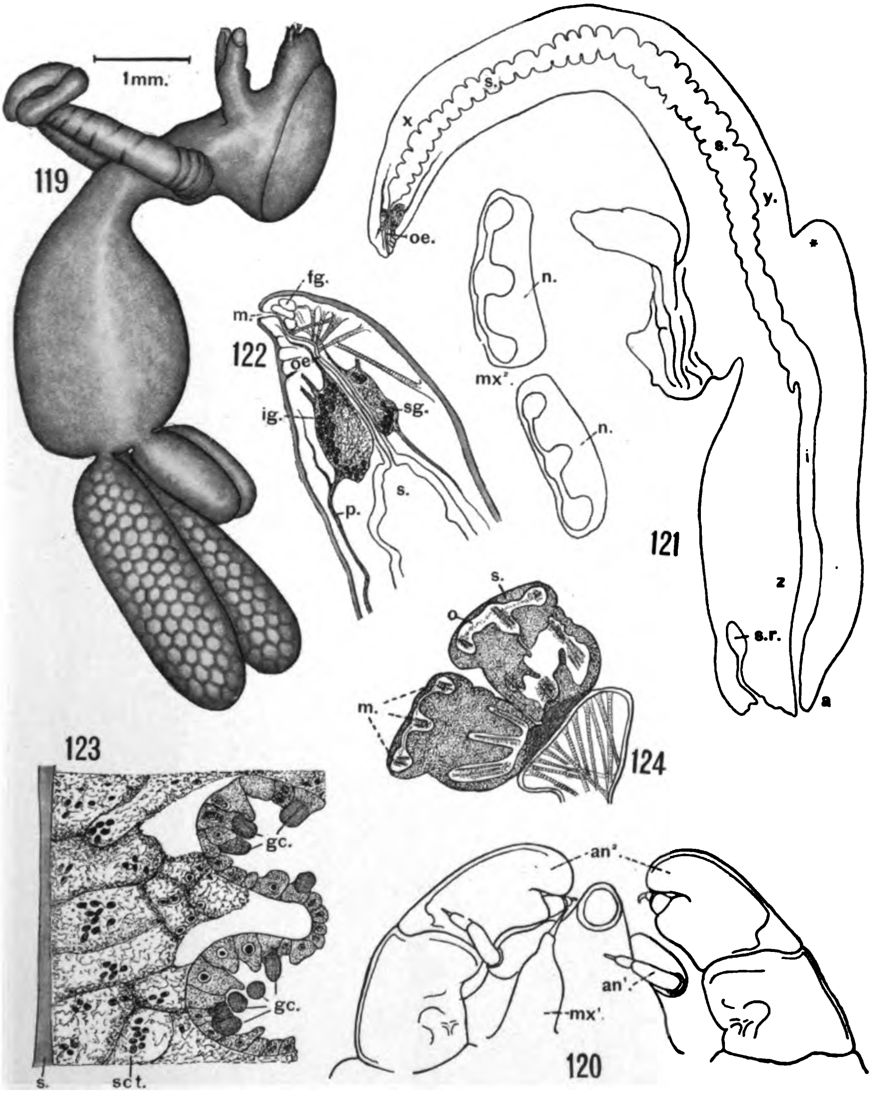
FEMALES OF LERNAEOPODINA RELATA AND TRACHELIASTES GRANDIS.

FOR EXPLANATION OF PLATE SEE PAGE 723.



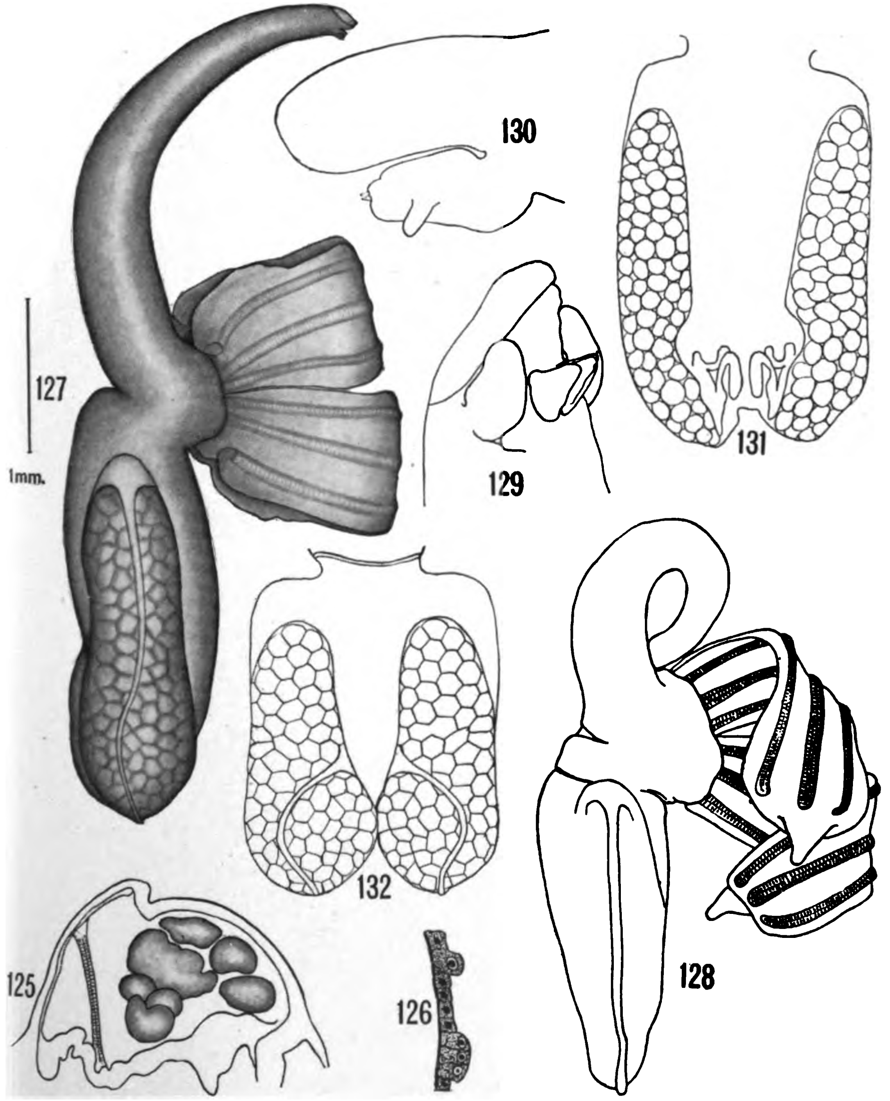
FEMALES OF BRIANELLA CORNIGER AND CHAROPINUS BICAUDATUS.

FOR EXPLANATION OF PLATE SEE PAGE 723.



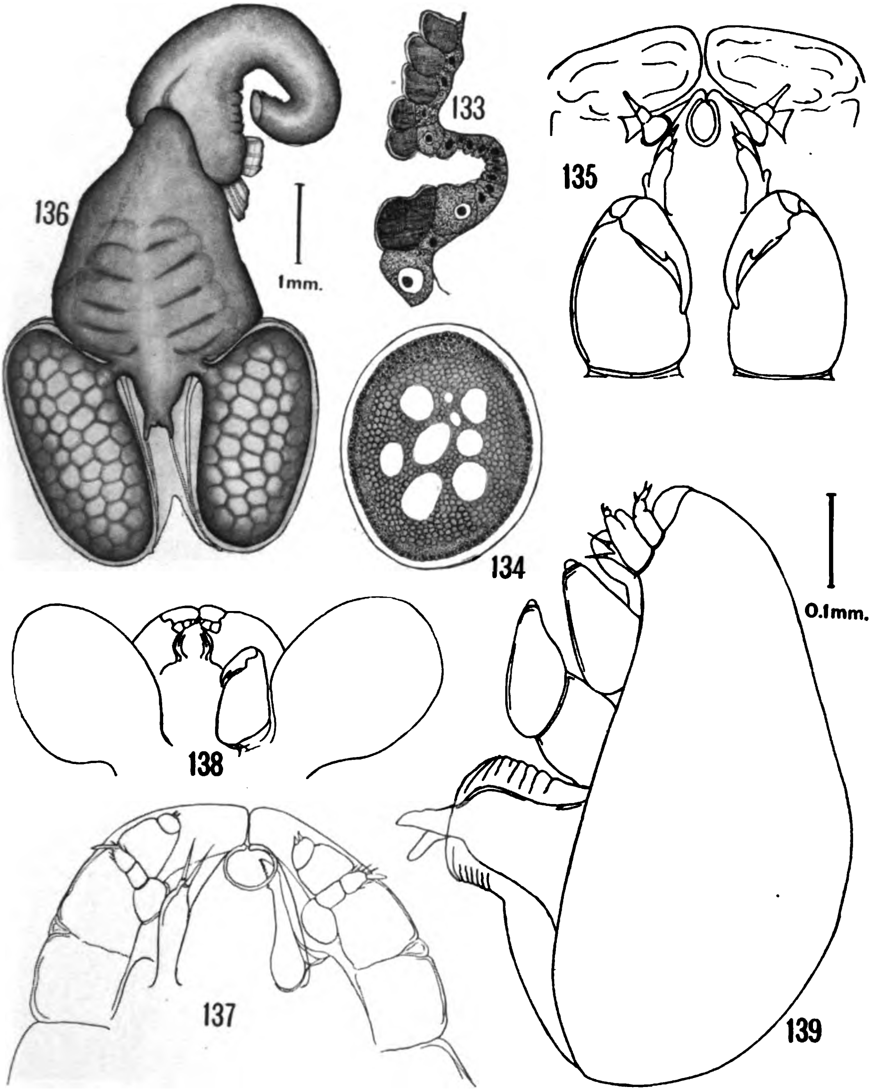
FEMALES OF CHAROPINUS BICAUDATUS AND NAOBRANCHIA LIZAE.

FOR EXPLANATION OF PLATE SEE PAGE 723.



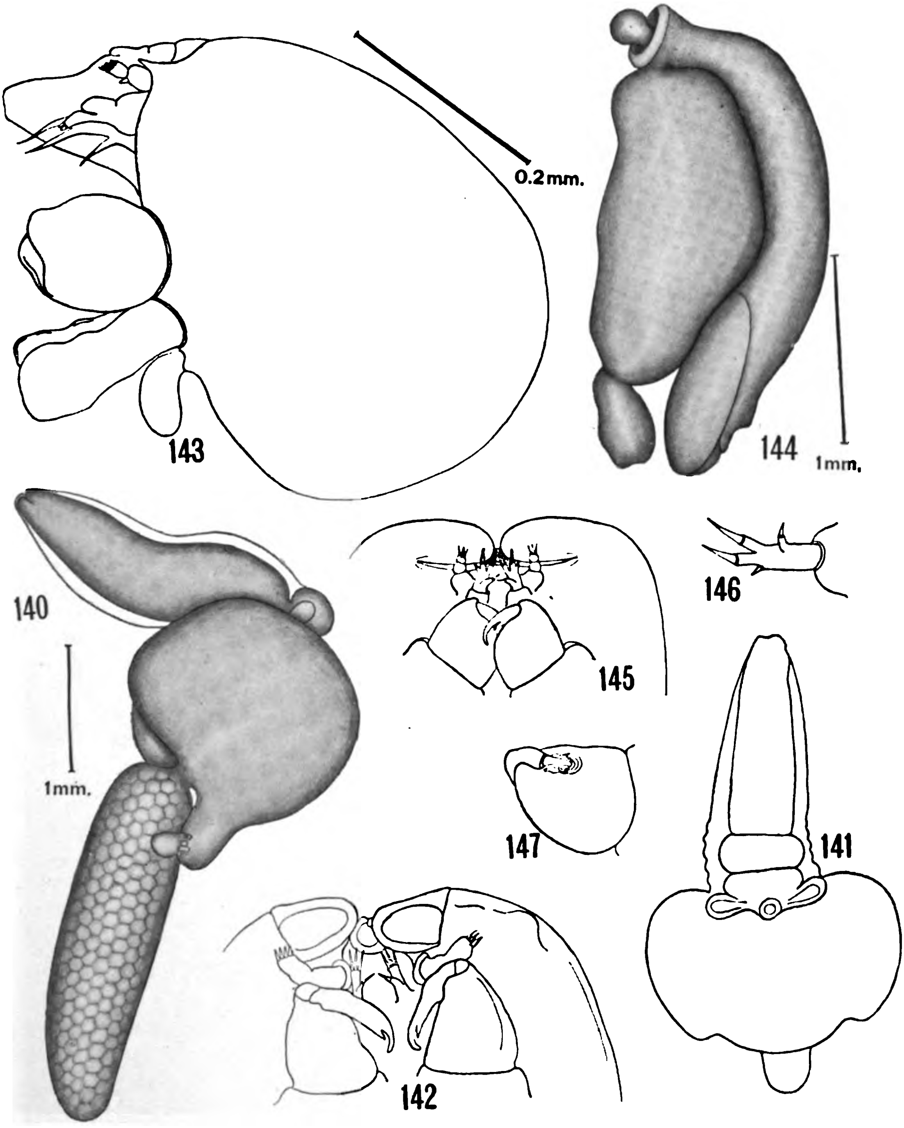
FEMALES OF NAOBRANCHIA LIZAE.

FOR EXPLANATION OF PLATE SEE PAGE 723.



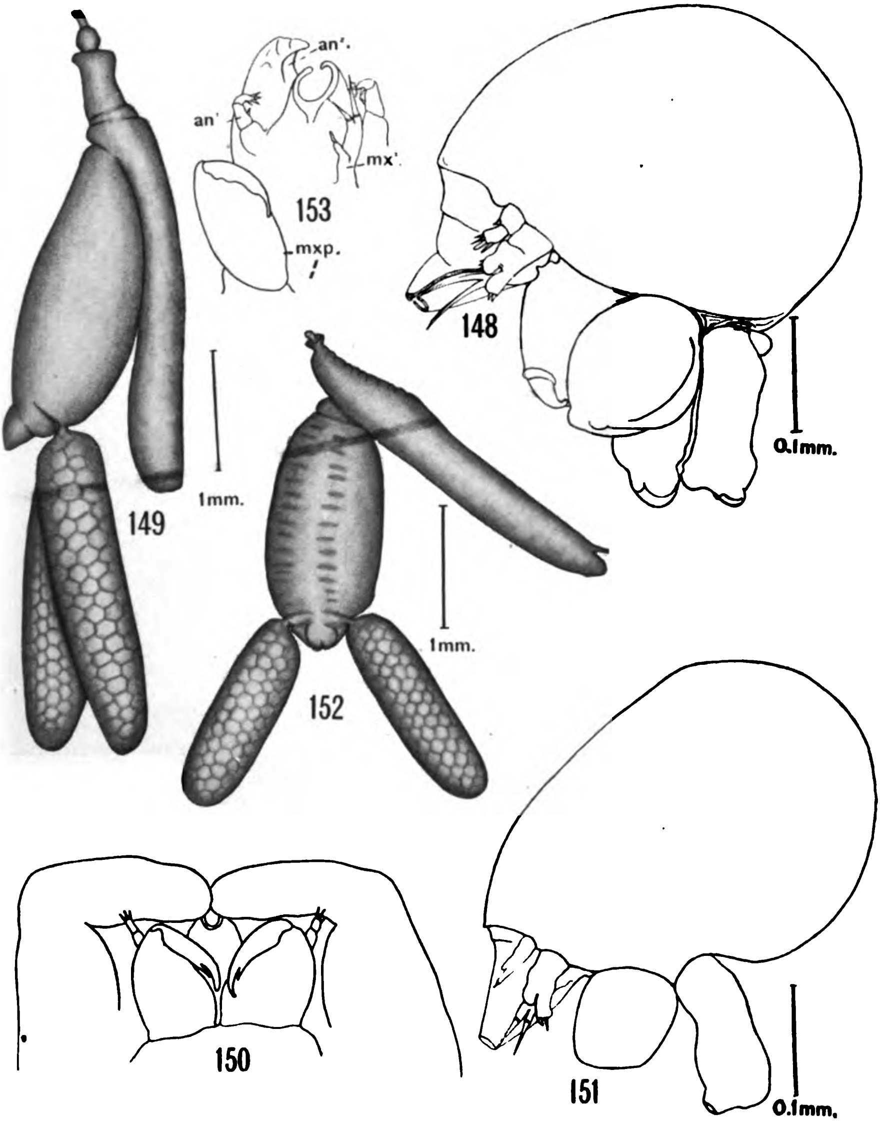
FEMALE AND MALE OF NAOBRANCHIA OCCIDENTALIS.

FOR EXPLANATION OF PLATE SEE PAGE 723.



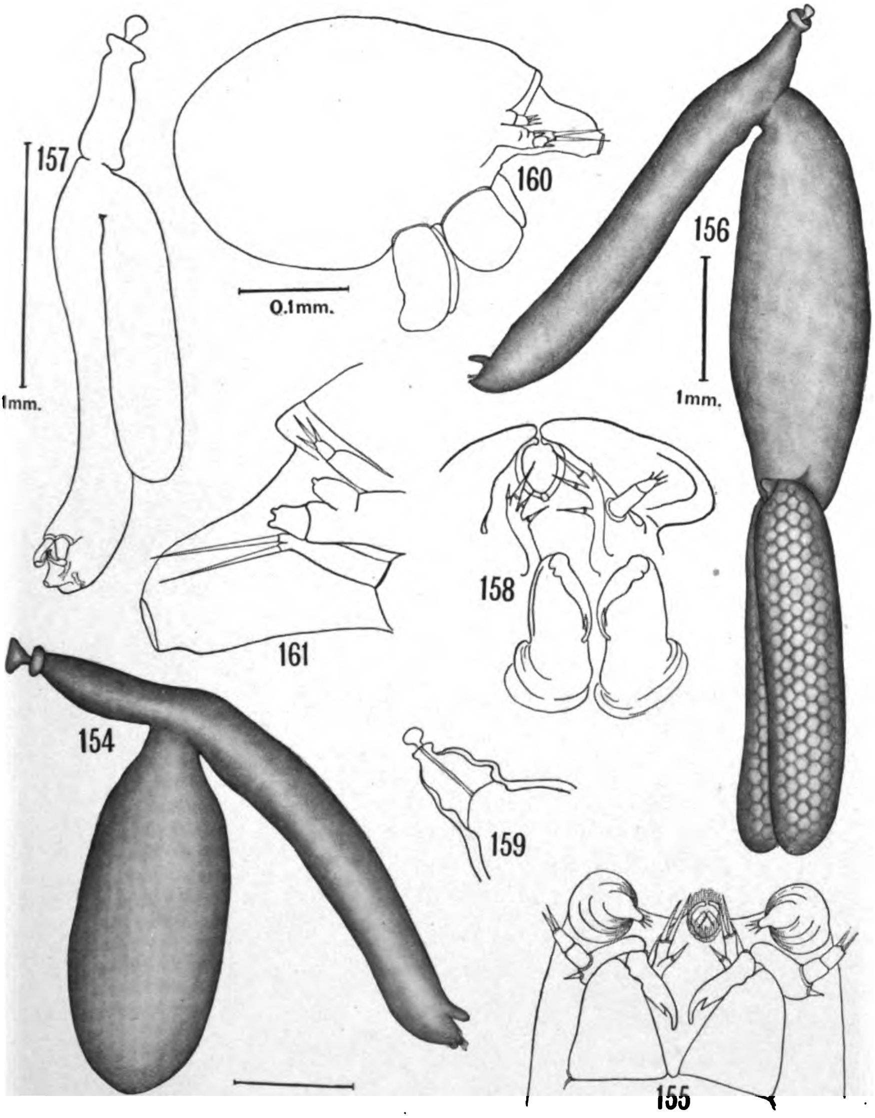
FEMALE AND MALE OF CLAVELLA PERFIDA, AND FEMALE OF C. TUMIDA.

FOR EXPLANATION OF PLATE SEE PAGE 724.



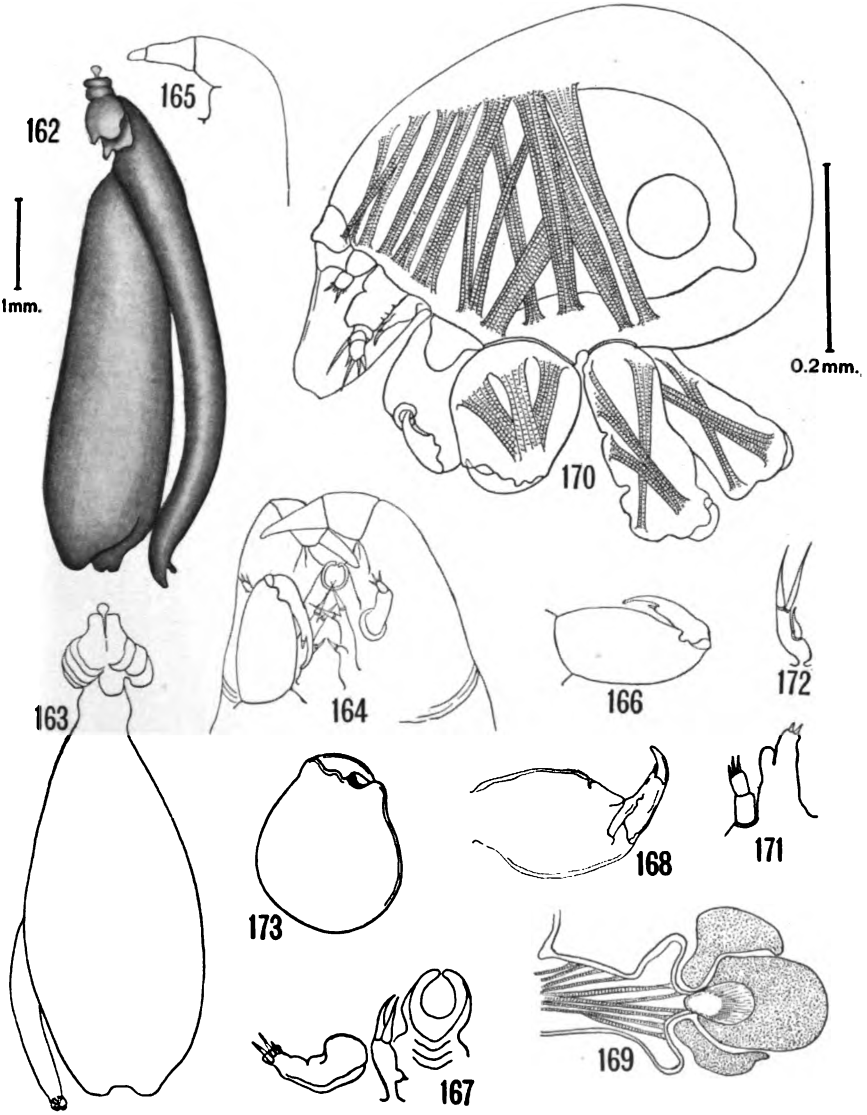
Male of Clavella tumida, Female and Male of C. canaliculata, and Female of C. insolita.

For explanation of plate see page 724.



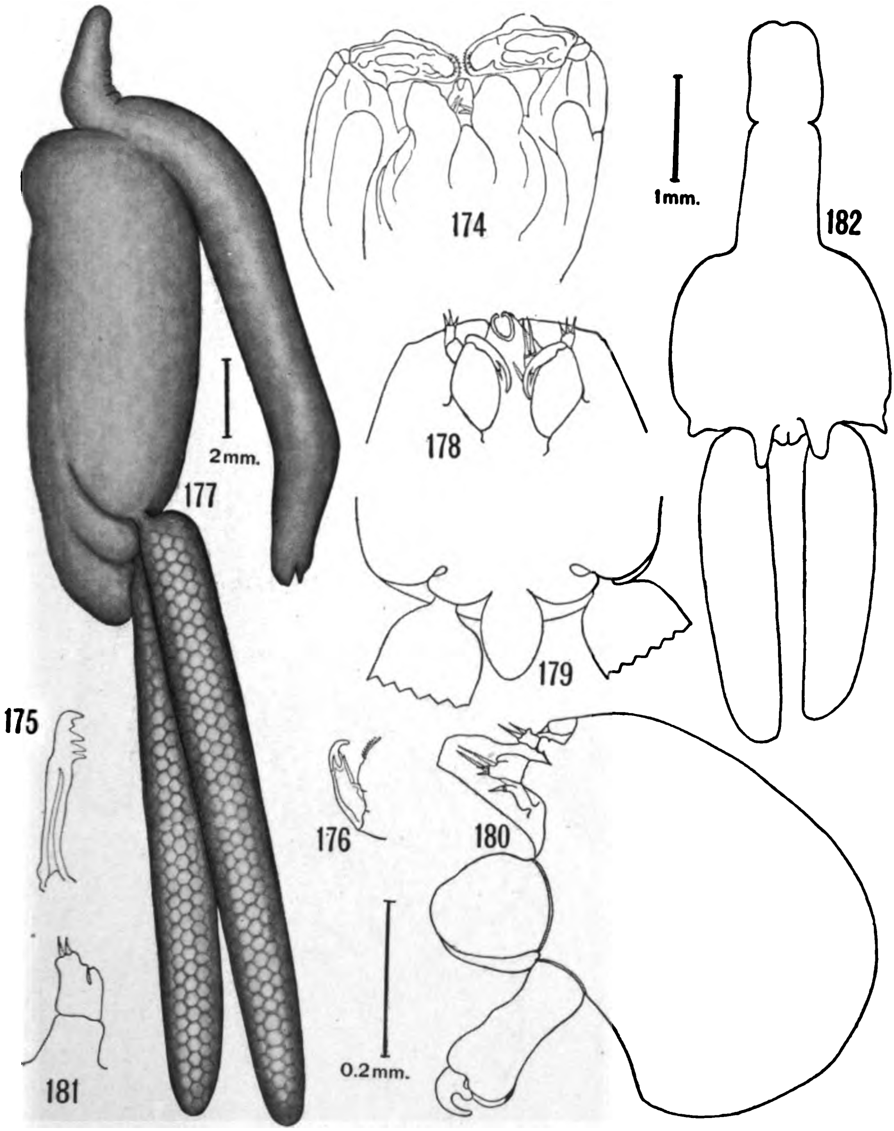
FEMALE OF CLAVELLA LEVIS, AND FEMALE AND MALE OF C. PINGUIS.

FOR EXPLANATION OF PLATE SEE PAGE 724.



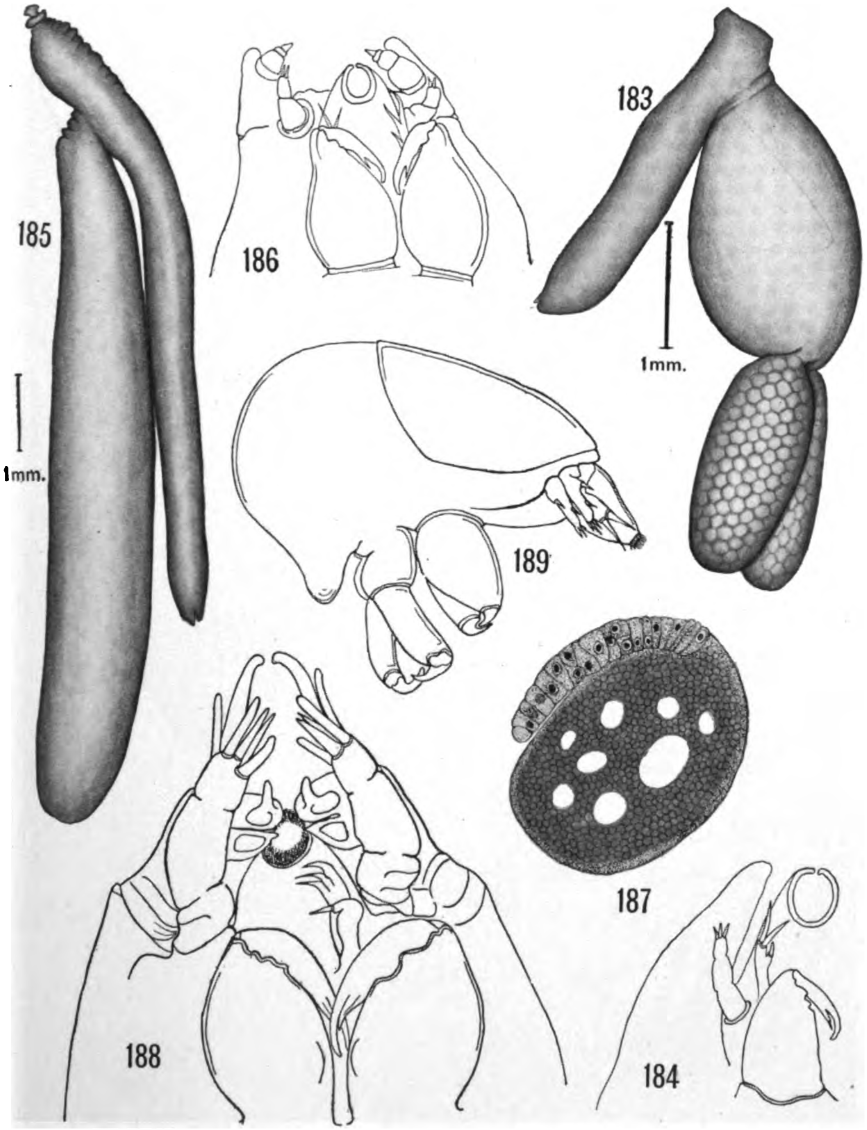
FEMALE OF CLAVELLA SQUAMIGERA, AND FEMALE AND MALE OF C. UNCINATA.

FOR EXPLANATION OF PLATE SEE PAGE 724.



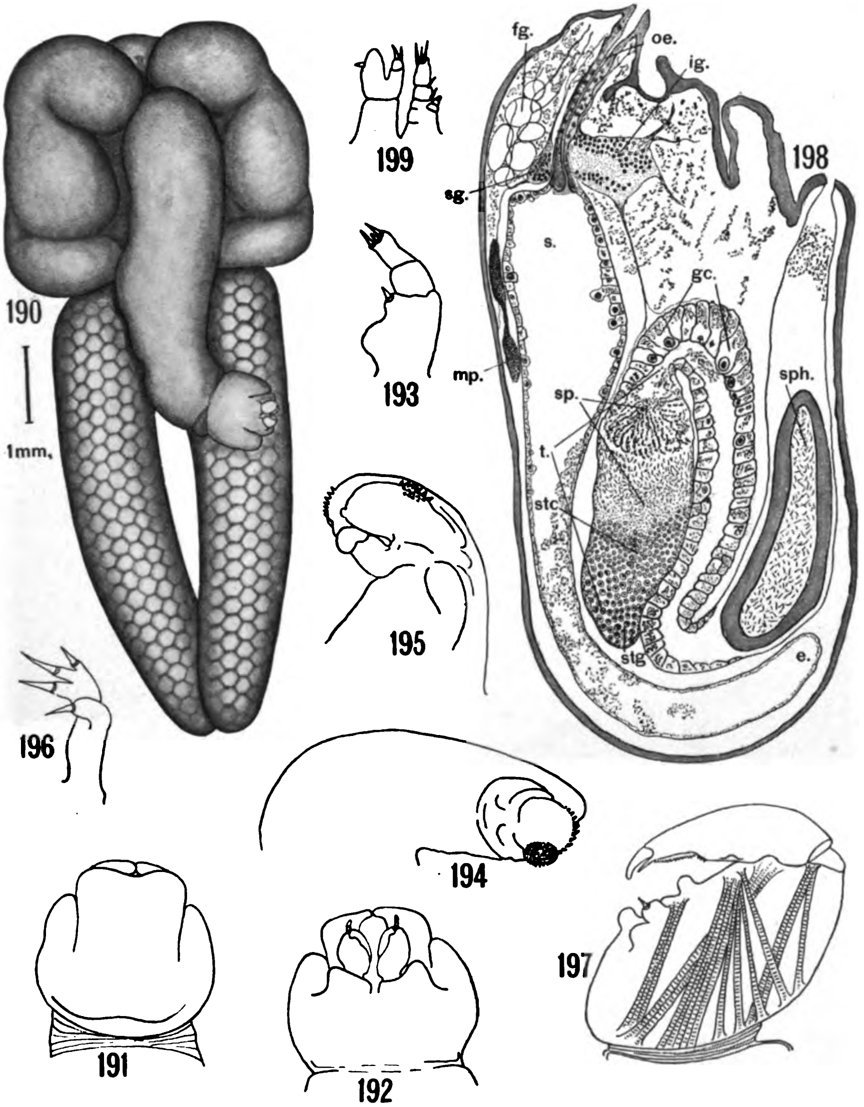
Female of Clavella uncinata, Female and Male of C. irina, and Female of Clavellopsis robusta.

For explanation of plate see page 724.



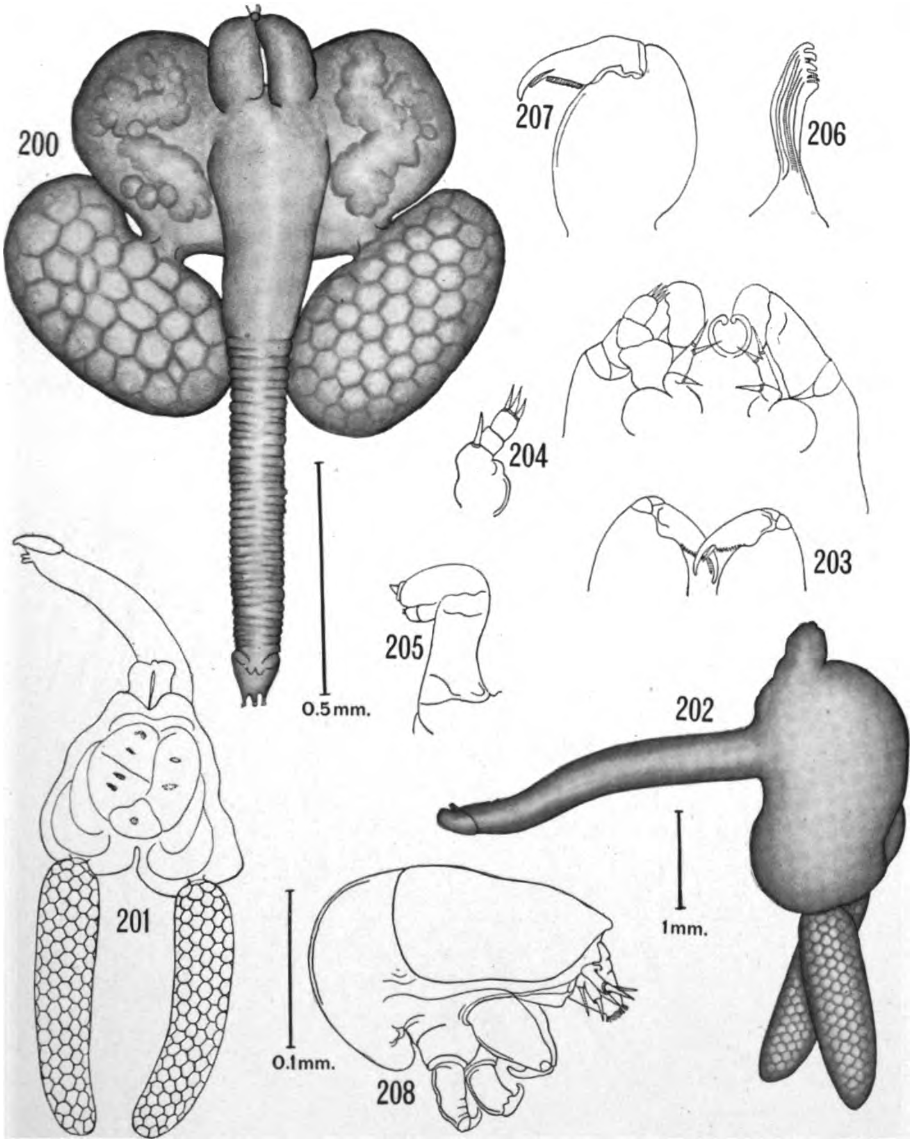
FEMALES OF CLAVELLA RECTA AND CLAVELLOPSIS PRODUCTA, AND FEMALE AND MALE OF CLAVELLISA SPINOSA.

FOR EXPLANATION OF PLATE SEE PAGE 724.



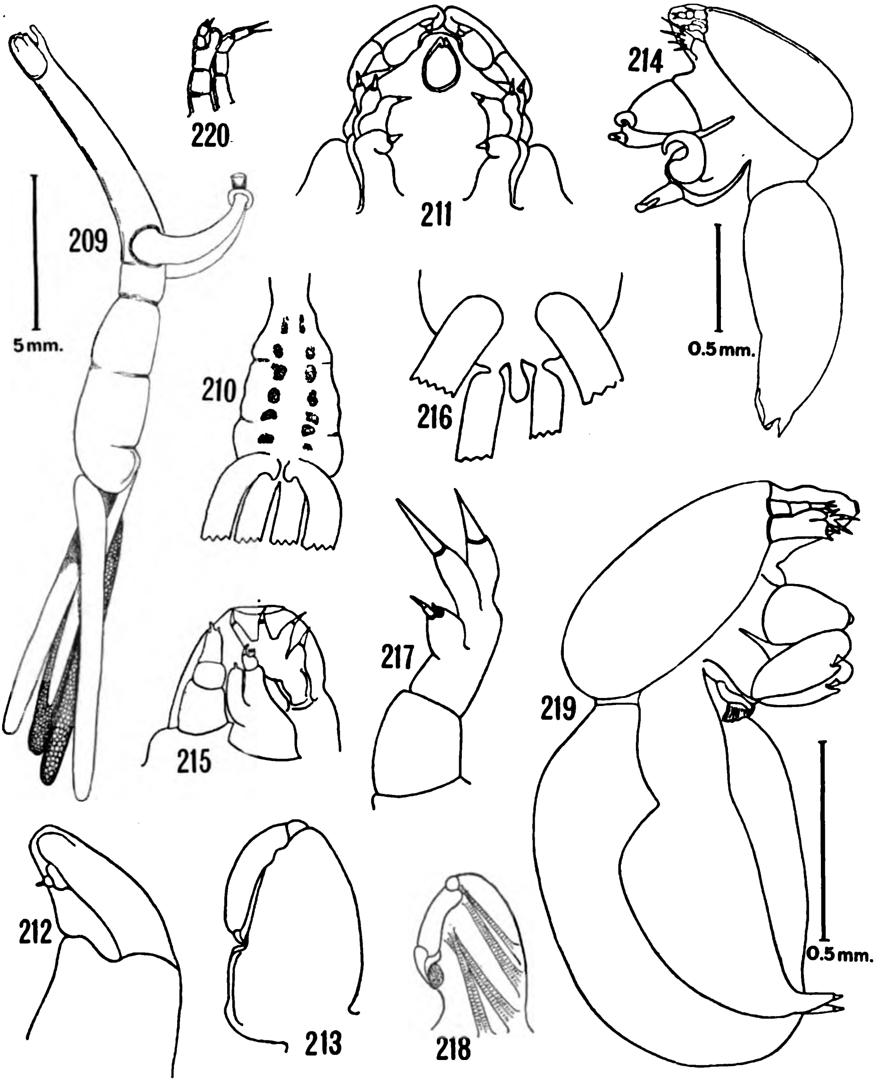
FEMALE AND MALE OF CLAVELLODES RUGOSA.

FOR EXPLANATION OF PLATE SEE PAGES 724, 725.



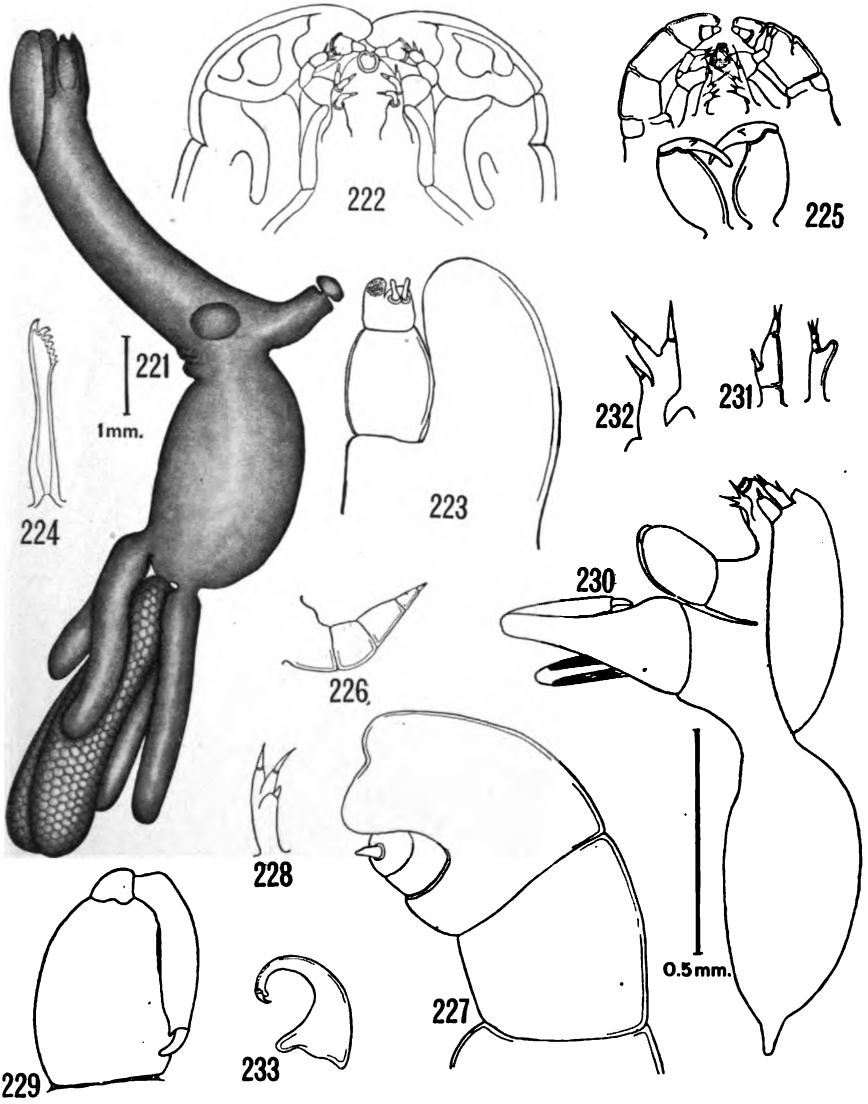
FEMALE OF CLAVELLISA SPINOSA AND FEMALE AND MALE OF C. CORDATA.

FOR EXPLANATION OF PLATE SEE PAGE 725.



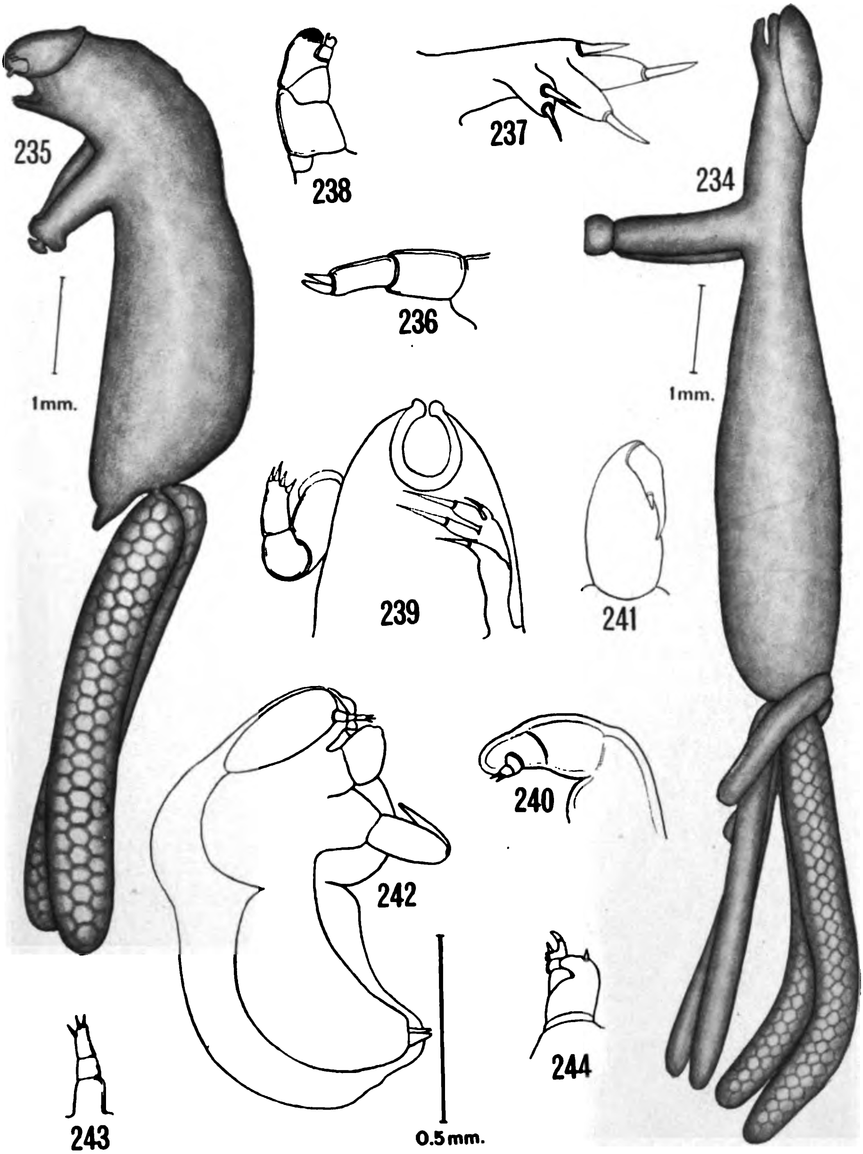
FEMALE AND MALE OF BRACHIELLA THYNNI AND B. GULOSA.

FOR EXPLANATION OF PLATE SEE PAGE 725.



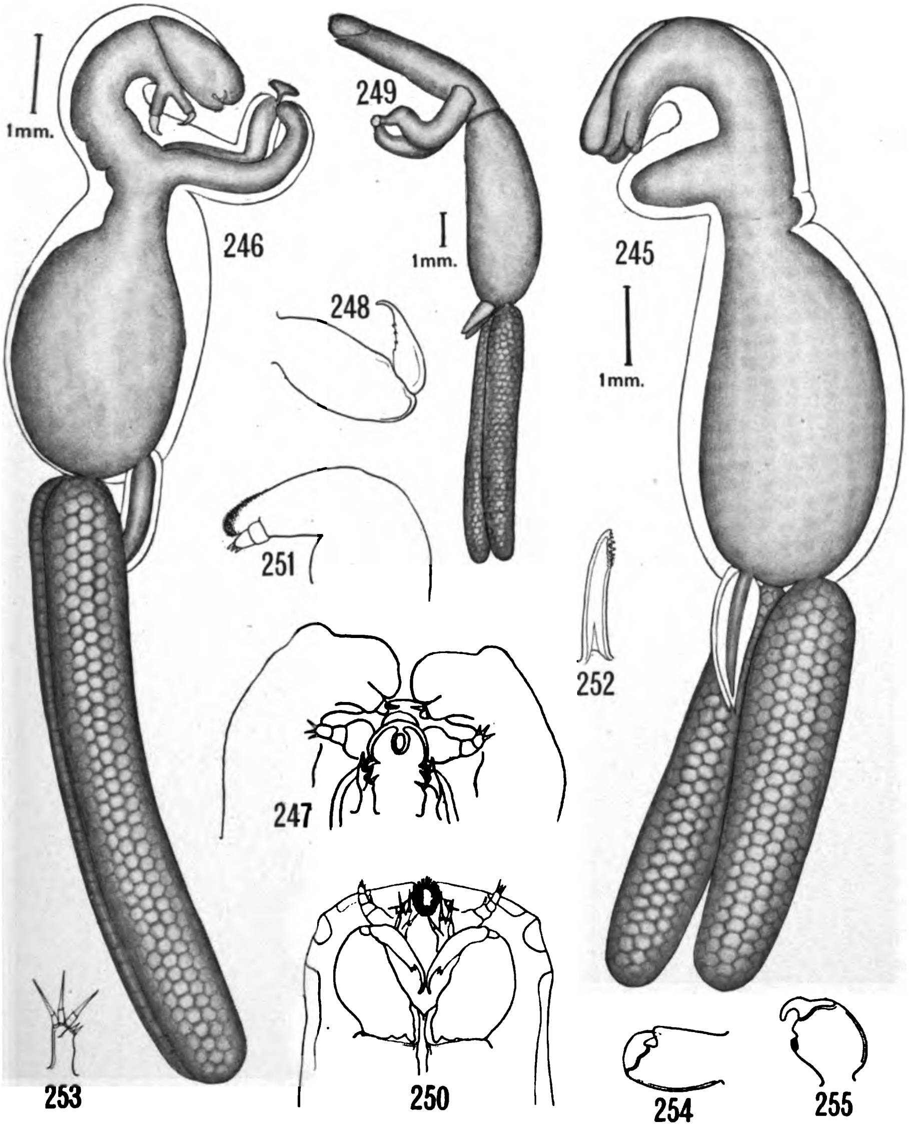
FEMALES OF BRACHIELLA GULOSA AND B. MITRATA, AND FEMALE AND MALE OF B. ELEGANS.

FOR EXPLANATION OF PLATE SEE PAGE 725.



FEMALES OF BRACHIELLA ELEGANS AND B. MITRATA, AND FEMALE AND MALE OF B. PINGUIS.

FOR EXPLANATION OF PLATE SEE PAGE 725.



FEMALES OF BRACHIELLA PINGUIS, B. NITIDA, AND PARABRACHIELLA ROSTRATA.

FOR EXPLANATION OF PLATE SEE PAGE 725.